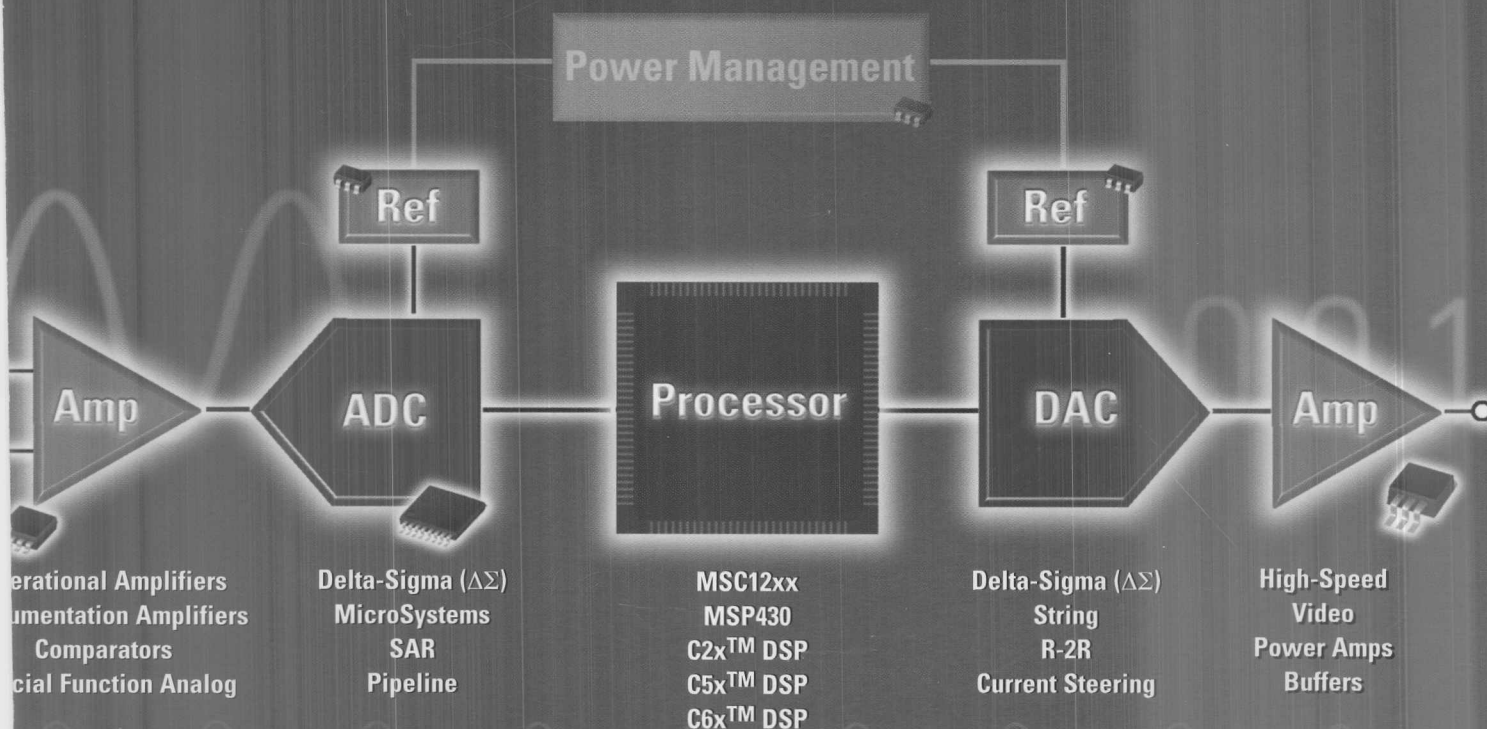


Amplifier and Data Converter Selection Guide

3Q 2005





Signal Chain

Amplifiers

Analog-to-Digital Converters

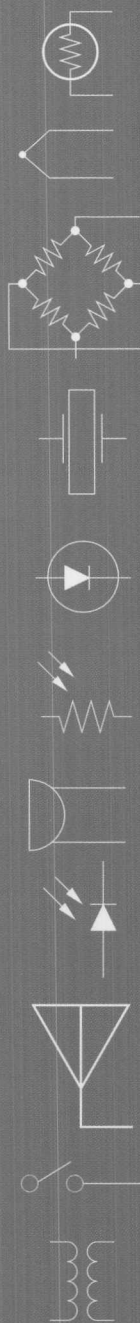
Digital-to-Analog Converters

System on a Chip (SoC)

Precision Analog

Technical Support

Inputs



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LDOs

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Battery Management

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$\Delta\Sigma$

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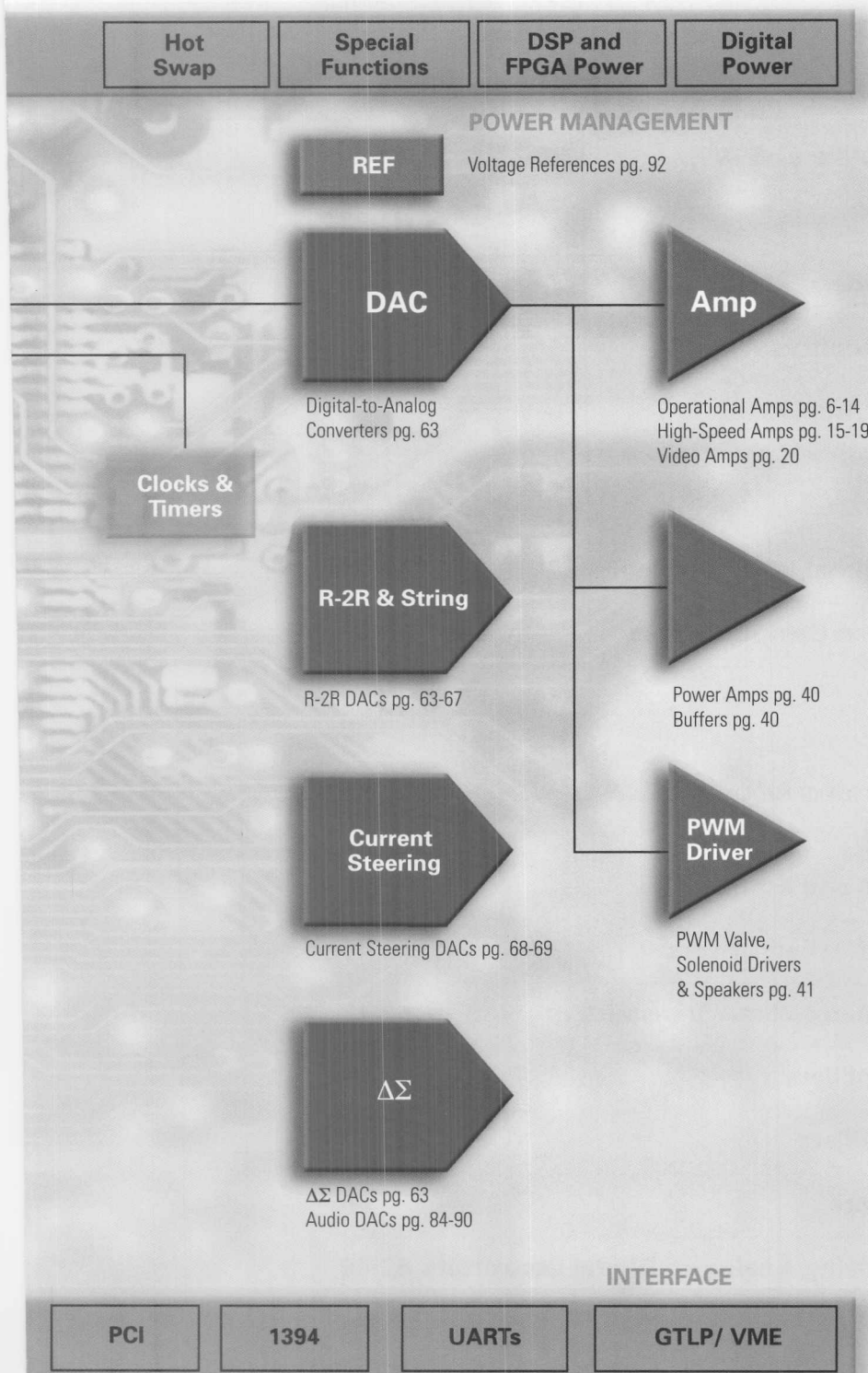
LVDS/MLVDS

RS-485/422

CAN

Serial Gigabit Transceiver

USB



Outputs

Amplifiers

- Operational Amplifiers
- High-Speed Amplifiers
- Comparators
- Instrumentation Amplifiers
- Signal Conditioning
- Power Amps and Buffers
- Special Function Analog

Analog-to-Digital Converters

- Delta-Sigma ADCs
- SAR ADCs
- Pipeline ADCs

Digital-to-Analog Converters

- Delta-Sigma DACs
- String and R-2R DACs
- Current Steering DACs

System on a Chip (SoC)

- MSC12xx MicroSystems
- Digital Signal Processors (DSP)
- MSP430 Microcontrollers

Precision Analog

- Analog Monitoring and Control
- Voiceband Codecs
- Touch Screen
- Audio Data Converters
- Temperature Sensors
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Technical Support

- Technology Primer
- Evaluation Modules
- Application Reports
- Part Finder

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Texas Instruments (TI) offers a wide range of op amp types including high precision, micropower, low voltage, high speed and rail-to-rail in several different process technologies. TI has developed the industry's largest selection of low-power and low-voltage op amps with features designed to satisfy a very wide range of applications. To help facilitate the selection process, an interactive online op amp parametric search engine is available at amplifier.ti.com/search with links to all op amp specifications.

Design Considerations

Choosing the best op amp for an application involves consideration of a variety of interrelated requirements. In doing so, designers must often consider conflicting size, cost and performance objectives. Even experienced engineers can find the task daunting, but it need not be so. Keeping in mind the following issues, the choices can quickly be narrowed to a manageable few.

Supply voltage (V_S)—tables include low voltage (< 2.7V min) and wide voltage range (> 5V min) sections. Other op amp selection criteria (e.g., precision) can be quickly examined in the supply range column for an appropriate choice. Applications operating from a single power supply may require rail-to-rail performance and consideration of precision-related parameters.

Precision—primarily associated with input offset voltage (V_{OS}) and its change with respect to temperature drift, PSRR and CMRR. It is generally used to

Common Op Amp Design Questions

What is the amplitude of the input signal?

To ensure signal errors are small relative to the input signal, small input signals require high precision (e.g., low offset voltage) amplifiers. Ensure that the amplified output signal stays within the amplifier output voltage.

Will the ambient temperature vary?

Op amps are sensitive to temperature variations, so it is important to consider offset voltage drift over temperature.

Does the common-mode voltage vary?

Make sure the op amp is operated within its common-mode range and has an adequate common-mode rejection ratio (CMRR). Common-mode voltage will induce additional offset voltage.

Does the power supply voltage vary?

Power supply variations affect the offset voltage. This may be especially important in battery-powered applications.

Precision Application Examples

- High gain circuits ($G > 100$)
- Measuring small input signals (e.g., from a thermocouple)
- Wide operating temperature range circuits (i.e., in automotive or industrial applications)
- Single-supply $\leq 5V$ data-acquisition systems where input voltage span is limited

describe op amps with low input offset voltage and low input offset voltage temperature drift. Precision op amps are required when amplifying tiny signals from thermocouples and other low-level sensors. High-gain or multi-stage circuits may require low offset voltage.

Gain bandwidth product (GBW)—the gain bandwidth of a voltage-feedback op amp determines its useful bandwidth in an application. The maximum available bandwidth is approximately equal to the gain bandwidth divided by the closed-loop gain of the application. For voltage feedback amplifiers, GBW is a constant. Many applications benefit from choosing

a much wider bandwidth/slew rate op amp to achieve low distortion, excellent linearity, good gain accuracy, gain flatness or other behavior that is influenced by feedback factors.

Power (I_Q requirements)—a significant issue in many applications. Because op amps can have a considerable impact on the overall system power budget, quiescent current, especially in battery-powered applications, is a key design consideration.

Rail-to-rail performance—rail-to-rail output provides maximum output voltage swing for widest dynamic range. This may be particularly important with low

Supply Voltage	Design Requirements	Typical Applications	Recommended Process	Recommended TI Amp Family
$V_S \leq 5V$	Rail-to-Rail, Low Power, Precision, Small Packages	Battery-Powered, Handheld	CMOS	OPA3xx, TLVxxxx
$V_S \leq 16V$	Rail-to-Rail, Low Noise, Low Voltage Offset, Precision, Small Packages	Industrial, Automotive	CMOS	OPA3x, TLCxxxx, OPA7xx
$V_S \leq +3V$	Low Input Bias Current, Low Offset Current, High Input Impedance	Industrial, Test Equipment, Optical Networking (ONET), High-End Audio	FET, DiFET	OPA1xx, OPA627
$V_S \leq +44V$	Low Voltage Offset, Low Drift	Industrial, Test Equipment, ONET, High-End Audio	Bipolar	OPA2xx, TLExxxx
$\pm 5V$ to $\pm 15V$ Dual Supply	High-Speed on Dual Supplies	XDSL, Video, Professional Imaging, Data Converter Signal Conditioning	DiFET, High-Speed Bipolar, BiCOM	OPA6xx*, OPA8xx*, THSxxxx*
$2.7V \leq V_S \leq 5V$ Single Supply	High-Speed on Single Supply	Consumer Imaging, Data Converter Signal Conditioning, Safety-Critical Automotive	High-Speed CMOS	OPA35x, OPA6xx*, THSxxxx*, OPA8xx*

*See High-Speed section, Page 15-20



Channels Single = No Character Dual = 2 Triple = 3 Quad = 4	Amp Class TLV = Low Supply Voltage TLC = 5V CMOS TLE = Wide Supply Voltage	Amp Class THS = High Speed
OPA V 3 63	TLV 278 x	THS x y 01
Base Model 100 = FET 200 = Bipolar 300 = CMOS ($\leq 5.5V$) 400 = High Voltage ($> 40V$) 500 = High Power ($> 200mA$) 600 = High-Speed ($> 50MHz$) 700 = CMOS (12V) 800 = High-Speed	Channels and Shutdown Options 0 = Single with Shutdown 1 = Single 2 = Dual 3 = Dual with Shutdown 4 = Quad 5 = Quad with Shutdown	Amplifier Type 30 = Current Feedback 31 = Current Feedback 40 = Voltage Feedback 41 = Fully Differential 42 = Voltage Feedback 43 = Fast Voltage Feedback 45 = Fully Differential 46 = Transimpedance 60 = Line Receiver 61 = Line Driver 70 = Programmable Gain

Op amp naming conventions.

operating voltage where signal swings are limited. Rail-to-rail input capability is often required to achieve maximum signal swing in buffer ($G = 1$) single-supply applications. It can be useful in other applications, depending on amplifier gain and biasing considerations.

Voltage noise (V_N)—amplifier-generated noise may limit the ultimate dynamic range, accuracy or resolution of a system. Low-noise op amps can improve accuracy, even in slow DC measurements.

Input bias current (I_B)—can create offset error by reacting with source or feedback impedance. Applications with high source impedance or high impedance feedback elements (such as transimpedance amplifiers or integrators) often require low input bias current. FET-Input and CMOS op amps generally provide very low input bias current.

Slew rate—the maximum rate of change of the amplifier output. It is important when driving large signals to high frequency. The available large signal bandwidth of an op amp is determined by the slew rate ($f = SR/2\pi A$).

Package size—TI offers a wide variety of micropackages, including WCSF, SOT23, SC70 and small, high power-dissipating PowerPAD™ packages to meet space-sensitive and high-output drive requirements. Many TI single-channel op amps are available in SOT23, with some dual amplifiers in SOT23-8.

Shutdown mode—an enable/disable function that places the amp in a high impedance state, reducing quiescent current in many cases to less than $1\mu A$. Allows designers to use wide bandwidth op amps in lower power applications.

Decompensated amplifiers—for applications with gain greater than unity gain ($G = 1$), decompensated amps provide significantly higher bandwidth, improved slew rate and lower distortion over their unity-gain stable counterparts on the same quiescent current or noise.

Op Amp Rapid Selector

The tables on the following pages have been subdivided into several categories to help quickly narrow the alternatives.

Precision $V_{OS} \leq 500\mu V$

Low Noise	pg 9
$V_N \leq 10nV/\sqrt{Hz}$	
Low Power	pg 9
$I_Q \leq 1mA/ch$	
Low Input Bias Current	pg 9
$I_B \leq 100pA$	
Wide Bandwidth	pg 10
$GBW \geq 5MHz$	
Low Voltage	pg 10
$V_S \leq 2.7V$	

Low Voltage $V_S \leq 2.7V$

Low Power	pgs 10-11
$I_Q \leq 1mA/ch$	
Wide Gain Bandwidth	pgs 11-12
$GBW \geq 5MHz$	

Low Supply Current $I_Q \leq 1mA/ch$

Low Voltage	pg 12
$V_S \leq 2.7V$	
Wide Bandwidth	pgs 12-13
$GBW \geq 5MHz$	

Wide Supply $\pm 5V \leq V_S \leq \pm 20V$

Precision	pgs 13-14
$V_{OS} \leq 500\mu V$	
Low Power	pgs 13-14
$I_Q \leq 1mA/ch$	
Low Input Bias Current	pgs 13-14
$I_B \leq 100pA$	
Wide Bandwidth	pgs 13-14
$GBW \geq 5MHz$	

Industry Standard

pg 14



Precision Operational Amplifiers

e-trim™ 20MHz, High-Precision CMOS Operational Amplifier OPA727, OPA728

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/OPA727, www.ti.com/sc/device/OPA728

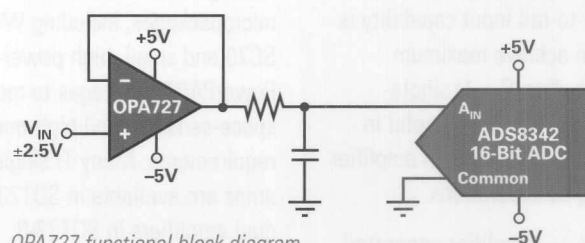
Key Features

- Offset: 15 μ V (typ), 150 μ V (max)
- Drift: 0.3 μ V/°C (typ), 1.5 μ V/°C (max)
- Bandwidth: 20MHz
- Slew rate: 30V/ μ s
- Bias current: 100pA (max)
- Low noise: 6nV/ $\sqrt{\text{Hz}}$ at 100kHz
- THD+N: 0.0003% at 1kHz
- Quiescent current: 4.3mA/ch
- Supply voltage: 4V to 12V
- Shutdown mode (OPA728): 6 μ A

Applications

- Optical networking
- Transimpedance amplifiers
- Integrators
- Active filters
- ADCs
- I/V converter for DACs
- High-performance audio
- Process control
- Test equipment

The OPA727 and OPA728 op amps use a state-of-the-art 12V analog CMOS process and e-trim™, a package-level trim, offering outstanding dc precision and ac performance. The extremely low offset (150 μ V max) and drift (1.5 μ V/°C) are achieved by trimming the IC digitally after packaging to avoid the shift in parameters that result from stresses during package assembly. To correct for offset drift, the OPA727/OPA728 family is trimmed over temperature. The devices feature very high CMRR and open loop gain to minimize errors. The OPA727 (single) and OPA727 (dual) are available in the tiny DFN-8 (3mm x 3mm) package.



OPA727 functional block diagram.

1.8V Nanopower Operational Amplifier OPA379

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/OPA379

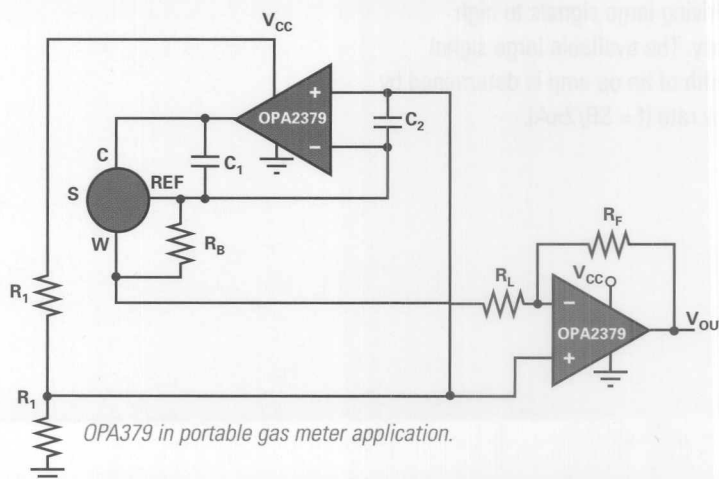
Key Features

- Low voltage:
1.8V to 5.5V single supply
- Low power: 5 μ A max
- Excellent bandwidth: 100kHz
- Rail-to-rail input and output
- Low bias current: 1pA
- Low noise: 75nV/ $\sqrt{\text{Hz}}$
- Packaging: SC-70

Applications

- Battery-powered instruments
- Photodiode monitoring
- Portable devices
- High impedance applications
- Medical instruments
- Precision integrators

The OPA379 is an ultra-low power (5 μ A max), 1.8V-capable op amp with low offset (1mV max). Offering an impressive 100kHz bandwidth and quiet 75nV/ $\sqrt{\text{Hz}}$ noise relative to its quiescent current, it is available in the small SC-70 package. The OPA379 also offers true rail-to-rail performance, making it useful in a wide range of power-sensitive applications.



OPA379 in portable gas meter application.

Precision Operational Amplifiers

Precision Operational Amplifiers ($V_{OS} \leq 500\mu V$) Selection Guide

Device	Description	Ch.	V_S (V) (min)	V_S (V) (max)	I_Q Per Ch. (mA) (max)	GBW (MHz) (typ)	Slew Rate (V/ μ s) (typ)	V_{OS} (25°C) (mV) (max)	Offset Drift (μ V/°C) (typ)	I_B (pA) (max)	CMRR (dB) (min)	V_N at 1kHz (nV/ \sqrt{Hz}) (typ)	Single Supply	Rail- to-Rail	Package(s)	Price ¹
Precision, Low Noise $V_N \leq 10nV/\sqrt{Hz}$ (typ) at 1kHz																
TLE2027	Precision, Low Noise, Wide Supply	1	8	38	5.3	13	2.8	0.1	0.4	90000	100	2.5	N	N	SOIC	\$0.90
OPAy227	Precision, Ultra-Low Noise	1, 2, 4	5	36	3.8	8	2.3	0.075	0.1	10000	120	3	N	N	PDIP, SOIC	\$1.10
OPAy228	Precision, Low Noise, $G \geq 5$	1, 2, 4	5	36	3.8	33	10	0.075	0.1	10000	120	3	N	N	PDIP, SOIC	\$1.10
OPAy350	Excellent ADC Driver, Low Noise Good AC and DC Performance	1, 2, 4	2.7	5.5	7.5	38	22	0.5	4	10	76	5	Y	I/O	PDIP, MSOP, SOIC, SSOP	\$1.30
OPA637	Decompensated OPA627 for $G \geq 5$	1	9	36	7.5	80	135	0.1	0.4	5	106	5.2	N	N	PDIP, SOIC	\$12.25
OPA627	Ultra-Low THD+N, DiFET	1	9	36	7.5	16	55	0.1	0.4	5	106	5.2	N	N	PDIP, SOIC	\$12.25
OPA124	Wide Bandwidth, Precision	1	10	36	7.5	1.5	1.6	0.25	2	1	100	8	N	N	PDIP, SOIC	\$3.95
OPAy277	High Precision, Low Power	1, 2, 4	4	36	0.825	1	0.8	0.02	0.1	1000	130	8	N	N	PDIP, SOIC	\$0.85
TLC220x	Wide Supply, Precision, Low Noise	1, 2	4.6	16	1.5	1.8	2.5	0.5	0.5	100	85	8	Y	Out	PDIP, SOIC	\$1.75
OPAy132	Wide Bandwidth, FET-Input	1, 2, 4	4.5	36	4.8	8	20	0.5	2	50	96	8	N	N	PDIP, SOIC	\$1.45
OPA727/8	20MHz e-trim™ Precision CMOS	1, 2, 4	4	12	4.3	25	30	0.15	0.3	100	86	10	Y	Out	MSOP, DFN	\$1.45
Precision, Low Power $I_Q \leq 1mA/ch$ (max)																
TLC1078	Low Voltage, Precision, Dual	2	1.4	16	0.017	0.085	0.032	0.45	1.1	600	70	68	N	—	SOIC, MSOP, PDIP	\$2.30
TLC27L7	Low Voltage, Dual	2	3	16	0.017	0.085	0.031	0.45	1.1	600	70	68	N	—	SOIC, MSOP, PDIP	\$0.75
OPAy241	Bipolar, μ Power $\pm 5V$ Supply	1, 2, 4	2.7	36	0.03	0.35	0.1	0.25	0.4	20000	80	45	Y	Out	PDIP, SOIC	\$1.15
OPAy251	Bipolar, μ Power, $\pm 15V$ Supply	1, 2, 4	2.7	36	0.03	0.35	0.1	0.25	0.4	20000	100	45	Y	Out	PDIP, SOIC	\$1.15
OPAy336	CMOS, μ Power	1, 2, 4	2.3	5.5	0.032	0.1	0.03	0.125	1.5	10	80	40	Y	Out	MSOP, PDIP, SOIC, SOT23	\$0.40
OPAy234	Low Power, Precision	1, 2, 4	2.7	36	0.3	0.35	0.2	0.1	0.5	-25000	96	25	Y	N	MSOP, SOIC	\$1.05
OPAy334	Zero Drift, Precision, CMOS, SHDN	1, 2	2.7	5.5	0.35	2	1.6	0.005	0.02	200	110	—	Y	Out	MSOP, SOIC, SOT23	\$0.95
OPAy335	Zero Drift, Precision, CMOS	1, 2	2.7	5.5	0.35	2	1.6	0.005	0.02	200	110	—	Y	Out	MSOP, SOIC, SOT23	\$0.95
OPAy734	12V, Auto-Zero, SHDN	1, 2	2.7	12	0.75	1.5	1.5	0.01	0.1	100	—	60	Y	Out	SOT23, MSOP, SOIC	\$1.25
OPAy735	12V, Auto-Zero, Precision Amp	1, 2	2.7	12	0.75	1.5	1.5	0.01	0.1	100	—	60	Y	Out	SOT23, MSOP, SOIC	\$1.25
OPAy363	1.8V, 90dB typ CMRR	1, 2	1.8	5.5	0.75	7	5	0.5	3	10	74	17	Y	I/O	MSOP, SOIC, SOT23	\$0.60
OPAy364	1.8V, 90dB typ CMRR	1, 2, 4	1.8	5.5	0.75	7	5	0.5	3	10	74	17	Y	I/O	MSOP, SOIC	\$0.60
OPAy277	High Precision, Low Power	1, 2, 4	4	36	0.825	1	0.8	0.02	0.1	1000	130	8	N	N	PDIP, SOIC	\$0.85
OPAy340	CMOS, Wide Bandwidth, <1mA	1, 2, 4	2.7	5.5	0.95	5.5	6	0.5	2.5	10	80	25	Y	I/O	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.80
OPAy380	Precision, 80MHz, TIA	1, 2	2.7	5.5	1	85	80	0.025	0.1	50	—	5 at 1MHz	Y	Out	MSOP, SOIC, SSOP	\$1.95
OPAy381	Precision, 18MHz, TIA	1, 2	2.7	5.5	1	18	12	0.025	0.1	50	—	5 at 1MHz	Y	Out	MSOP, DFN	\$1.45
Precision, Low Input Bias Current $I_B \leq 100pA$ (max)																
OPA124	Low Noise, Precision	1	10	36	7.5	1.5	1.6	0.25	2	1	100	8	N	N	PDIP	\$3.95
OPA627	Ultra-Low THD+N, DiFET	1	9	36	7.5	16	55	0.1	0.4	1	106	5.2	N	N	PDIP, SOIC	\$12.25
OPA637	Decompensated OPA627, $G \geq 5$	1	9	36	7.5	80	135	0.1	0.4	1	106	5.2	N	N	PDIP, SOIC	\$12.25
OPA727/8	20MHz e-trim Precision CMOS	1, 2, 4	4	12	4.3	25	30	0.15	0.3	100	86	10	Y	I	MSOP, DFN	\$1.45
OPAy336	SS, μ Power CMOS Amp	1, 2, 4	2.3	5.5	0.032	0.1	0.03	0.125	1.5	10	80	40	Y	Out	MSOP, PDIP, SOIC, SOT23	\$0.40
OPAy340	CMOS, Wide Bandwidth	1, 2, 4	2.7	5.5	0.95	5.5	6	0.5	2.5	10	80	25	Y	I/O	MSOP, SOIC, SOT23, TSSOP	\$0.80
OPAy350	Excellent ADC Driver, Low Noise Good AC and DC Performance	1, 2, 4	2.7	5.5	7.5	38	22	0.5	4	10	76	5	Y	I/O	PDIP, MSOP, SOIC	\$1.30
OPA344	Low Power, RRIO, SS	1, 2, 4	2.7	5.5	0.25	1	1	0.5	2.5	10	80	32	Y	I/O	MSOP, DIP, SOIC	\$0.70
OPA363	1.8V, RRIO, High CMRR	1, 2	2.7	5.5	0.75	7	5	0.5	3	10	74	17	Y	I/O	MSOP, SOIC, SOT23	\$0.80
OPAy380	Precision, 80MHz, TIA	1, 2	2.7	5.5	1	85	80	0.025	0.1	50	—	5 at 1MHz	Y	Out	MSOP, SOIC, SSOP	\$1.95
OPAy381	Precision, 18MHz, TIA	1, 2	2.7	5.5	1	18	12	0.025	0.1	50	—	5 at 1MHz	Y	Out	MSOP, DFN	\$1.45
OPAy132	Wide Bandwidth, FET-Input	1, 2, 4	4.5	36	4.8	8	20	0.5	2	50	96	8	N	N	PDIP, SOIC	\$1.45
OPAy735	12V, AutoZero, Precision Amp	1, 2	2.7	12	0.75	2	1.5	0.01	0.1	100	—	60	Y	Out	SOT23, MSOP, SOIC	\$1.25
OPAy734	12V, Precision, SHDN	1, 2	2.7	12	0.75	2	1.5	0.01	0.1	100	—	60	Y	Out	SOT23, MSOP, SOIC	\$1.25
TLC220x	Precision, Low Noise	1, 2	4.6	16	1.5	1.8	2.5	0.5	0.5	100	85	8	Y	Out	PDIP, SOIC	\$1.65

¹ Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in bold red.



Precision Operational Amplifiers/Low-Voltage Operational Amplifiers

Precision Operational Amplifiers ($V_{OS} \leq 500\mu V$) Selection Guide (Continued)

Device	Description	Ch.	V_S (V)	V_S (V)	I_Q Per Ch. (mA)	GBW (MHz)	Slew Rate (V/ μ s)	V_{OS} (25°C) (mV)	Offset Drift (μ V/°C)	I_B (pA)	CMRR (dB)	V_N at 1kHz (nV/ \sqrt{Hz})	Single Supply	Rail- to- Rail	Package(s)	Price ¹
Precision, Wide Bandwidth GBW ≥ 5 MHz (typ)																
OPAy340	CMOS, Wide Bandwidth	1, 2, 4	2.7	5.5	0.95	5.5	6	0.5	2.5	10	80	25	Y	I/O	MSOP, SOIC, SOT23, TSSOP	\$0.73
TLE2141	Low Noise, Precision	1, 2, 4	4	44	4.5	5.9	45	0.5	1.7	2	85	10.5	Y	—	DIP, SOIC	\$0.65
OPAy363	1.8V, High CMRR, SHDN	1, 2	1.8	5.5	0.75	7	5	0.5	3	10	74	17	Y	I/O	MSOP, SOIC, SOT23	\$0.80
OPAy364	1.8V, High CMRR, RRIO	1, 2, 4	1.8	5.5	0.75	7	5	0.5	3	10	74	17	Y	I/O	MSOP, SOIC, SOT23, TSSOP	\$0.80
OPAy132	Wide Bandwidth, FET-Input	1, 2, 4	4.5	36	4.8	8	20	0.5	2	50	96	8	N	N	PDIP, SOIC	\$7.95
OPAy227	Precision, Ultra-Low Noise	1, 2, 4	5	36	3.8	8	2.3	0.075	0.1	10000	120	3	N	N	PDIP, SOIC	\$7.40
TLE2027	Precision, Low Noise	1	8	38	5.3	13	2.8	0.1	0.4	90000	100	2.5	N	N	SOIC	\$1.60
OPA627	Ultra Low THD, DiFET	1	9	36	7.5	16	55	0.1	0.4	5	106	5.2	N	N	PDIP, SOIC	\$12.25
OPA727/8	20MHz e-trim™ Precision CMOS	1, 2, 4	4	12	4.3	25	30	0.15	0.3	100	86	10	Y	Out	MSOP, DFN	\$2.00
OPAy228	Precision, Low Noise, $G \geq 5$	1, 2, 4	5	36	3.8	33	10	0.075	0.1	10000	120	3	N	N	PDIP, SOIC	\$1.10
OPAy350	CMOS, 38MHz	1, 2, 4	2.7	5.5	7.5	38	22	0.5	4	10	76	5	Y	I/O	PDIP, MSOP, SOIC	\$1.30
OPA637	Wide Bandwidth, Precision	1	9	36	7.5	80	135	0.1	0.4	10	106	5.2	N	N	PDIP, SOIC	\$12.25
OPAy380	Precision, 80MHz, TIA	1, 2	2.7	5.5	1	85	80	0.025	0.1	50	—	5 at 1MHz	Y	Out	MSOP, SOIC, SSOP	\$1.95
OPAy381	Precision, 18MHz, TIA	1, 2	2.7	5.5	1	18	12	0.025	0.1	50	—	5 at 1MHz	Y	Out	MSOP, DFN	\$1.45
Precision, Low Voltage $V_S \leq 2.7$ V (min)																
TLC1078	Low Voltage, Precision	2	1.4	16	0.017	0.085	0.032	0.45	1.1	70	600	68	N	—	SOIC, SOP, PDIP	\$2.30
OPAy363	High CMRR, Shutdown	1, 2	1.8	5.5	0.75	7	5	0.5	2	10	74	17	Y	I/O	MSOP, SOIC, SOT23	\$0.80
OPAy364	1.8V, High CMRR, RRIO, SS	1, 2, 4	1.8	5.5	0.75	7	5	0.5	2	10	74	17	Y	I/O	MSOP, SOIC, SOT23, TSSOP	\$0.80
OPAy336	SS, μ Power CMOS Amplifier	1, 2, 4	2.3	5.5	0.032	0.1	0.03	0.125	1.5	10	80	40	Y	Out	MSOP, PDIP, SOIC, SOT23	\$0.99
OPAy334	Zero Drift, Precision, CMOS, SHDN	1, 2	2.7	5.5	0.35	2	1.6	0.005	0.02	200	110	—	Y	Out	MSOP, SOIC, SOT23	\$0.95
OPAy335	Zero Drift, Precision, CMOS	1, 2	2.7	5.5	0.35	2	1.6	0.005	0.02	200	110	—	Y	Out	MSOP, SOIC, SOT23	\$0.95
OPAy234	Low Power, Precision	1, 2, 4	2.7	36	0.3	0.35	0.2	0.1	0.5	25000	96	25	Y	N	MSOP, SOIC	\$1.50
OPAy241	Bipolar, μ Power, High CMRR	1, 2, 4	2.7	36	0.025	0.35	0.1	0.25	0.4	2000	124	45	Y	Out	PDIP, SOIC	\$1.15
OPAy340	CMOS, Wide Bandwidth, <1 mA	1, 2, 4	2.7	5.5	0.95	5.5	6	0.5	2.5	10	80	25	Y	I/O	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.70
OPAy380	Precision, 80MHz, TIA	1, 2	2.7	5.5	1	85	80	0.025	0.1	50	—	5 at 1MHz	Y	Out	MSOP, SOIC, SSOP	\$1.95
OPAy381	Precision, 18MHz, TIA	1, 2	2.7	5.5	1	18	12	0.025	0.1	50	—	5 at 1MHz	Y	Out	MSOP, DFN	\$1.45
OPAy350	Excellent ADC Driver, Low Noise Good AC and DC Performance	1, 2, 4	2.7	5.5	7.5	38	22	0.5	4	10	76	5	Y	I/O	PDIP, MSOP, SOIC, SSOP	\$1.30

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**.Low-Voltage Operational Amplifiers ($V_S \leq 2.7$) Selection Guide

Device	Description	Ch.	SHDN	V_S (V)	V_S (V)	I_Q Per Ch. (mA)	GBW (MHz)	Slew Rate (V/ μ s)	V_{OS} (25°C) (mV)	Offset Drift (μ V/°C)	I_B (pA)	V_N at 1kHz (nV/ \sqrt{Hz})	Rail- to- Rail	Package(s)	Price ¹
Low Voltage, Low Power $I_Q \leq 1$ mA (max)															
TLV2401	Lowest Power Op Amp, Wide Supply Range, Input Range Beyond the Rails	1, 2, 4	N	2.5	16	0.0095	0.0055	0.0025	1.2	3	300	800	I/O	SOT-23, MSOP, SOIC, PDIP, TSSOP	\$1.20
OPA379	1.8V, Ultra-Low Power, Low Offset	1, 2, 4	N	1.8	5.5	0.0045	0.1	0.03	1	4	10	100	I/O	SC-70, SOT-23, MSOP	\$0.70
TLV2241	1 μ A, Good CMRR, Low Offset	1, 2, 4	N	2.5	12	0.0012	0.0055	0.002	3	3	500	800	I/O	SOT-23, MSOP, PDIP, SOIC, TSSOP	\$0.60
OPAy349	Ultra-Low Power CMOS in SC-70	1, 2	N	1.8	5.5	0.002	0.07	0.02	10	15	10	300	I/O	SC-70, SOT-23, SOIC, SOT23-8 Dual	\$0.75
TLV2381	10 μ A General-Purpose Op Amp	1, 2	N	2.7	16	0.01	0.16	0.06	4.5	1.1	60	90	I/O	SOT-23, SOIC	\$0.60
TLC1078	Low Voltage, Precision	2	N	1.4	16	0.017	0.085	0.032	0.45	1.1	600	68	—	SOIC, SOP, PDIP	\$2.30
TLC1079	Low Voltage, Precision	4	N	1.4	16	0.017	0.085	0.032	0.85	1.1	600	68	—	SOIC, SOP, PDIP	\$3.20
TLV2211	Very Low Noise, Low-Power Op Amp	1	N	2.7	10	0.025	0.056	0.025	3	1	150	22	Out	SOT-23	\$0.42
TLV2760	1.8V, Good Speed/Power, Low I_B	1, 2, 4	Y	1.8	3.6	0.028	0.5	0.2	3.5	9	15	95	I/O	SOT-23, MSOP, SOIC, PDIP, TSSOP	\$0.65
OPAy380	Precision, High-Speed, TIA	1, 2	Y	2.7	5.5	1	85	80	0.025	0.1	50	5 at 1MHz	Out	MSOP, SOIC, SSOP	\$1.95
OPAy381	Precision, 18MHz, TIA	1, 2	Y	2.7	5.5	1	18	12	0.025	0.1	50	5 at 1MHz	Out	MSOP, DFN	\$1.45

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.

Low-Voltage Operational Amplifiers

Low-Voltage Operational Amplifiers ($V_S \leq 2.7$) Selection Guide

Device	Description	Ch.	SHDN	V_S (V) (min)	V_S (V) (max)	I_Q Per Ch. (mA) (max)	GBW (MHz) (typ)	Slew Rate (V/ μ s) (typ)	V_{OS} (25°C) (mV) (max)	Offset Drift (μ V/°C) (typ)	I_B (pA) (max)	V_N at 1kHz (nV/ \sqrt{Hz}) (typ)	Rail- to- Rail	Package(s)	Price ¹
Low Voltage, Low Power $I_Q \leq 1\text{mA}$ (max) (Continued)															
OPAy336	μ Power, Precision Op Amp	1, 2, 4	N	2.3	5.5	0.032	0.1	0.03	0.125	1.5	10	40	Out	SOT-23, MSOP, SOIC, PDIP	\$0.99
OPAy347	μ Power, Low I_B , SC-70	1, 2, 4	N	2.3	5.5	0.034	0.35	0.17	6	2	10	60	I/O	WCSP, SC-70, SOT-23, SOIC, TSSOP SOT23-8(D), TSSOP	\$0.48
TLV2450	μ Power, Shutdown, RRIO 10mA Drive Capability	1, 2, 4	Y	2.7	6	0.035	0.22	0.12	1.5	0.3	5000	51	I/O	SOT-23, MSOP, PDIP, SOIC, TSSOP	\$0.65
OPAy348	Excellent Speed/Power, High Open-Loop Gain	1, 2, 4	N	2.1	5.5	0.065	1	0.5	5	2	10	35	I/O	SC-70, SOT-23, SOIC, SOT23-8(D), TSSOP	\$0.45
OPAy334	Auto-Zero Amp, Lowest Offset and Drift, Low Power, Shutdown	1, 2	Y	2.7	5.5	0.35	2	1.6	0.005	0.02	200	—	Out	SOT-23, MSOP, SOIC	\$1.00
OPAy335	Auto-Zero Amp, Lowest Offset and Drift, Low Power	1, 2	N	2.7	5.5	0.35	2	1.6	0.005	0.02	200	—	Out	SOT-23, MSOP, SOIC	\$1.00
OPA379	1.8V, Ultra-Low Power, Low Offset	1, 2, 4	N	1.8	5.5	0.0045	0.1	0.03	1	4	10	100	I/O	SC-70, SOT-23, MSOP	\$0.70
TLV2460	Low Noise, Wide Bandwidth, 25mA Drive	1, 2, 4	Y	2.7	6	0.575	5.2	1.6	2	2	14000	11	I/O	SOT-23, MSOP, SOIC, PDIP, TSSOP	\$0.65
OPAy374	Low Cost CMOS, General Purpose	1, 2, 4	N	2.3	5.5	0.75	6.5	5	5	3	10	15	I/O	SOT-23, TSSOP, SOIC	\$0.36
OPAy373	Shutdown Version of OPA374	1, 2	Y	2.3	5.5	0.75	6.5	5	5	3	10	15	I/O	SOT-23, MSOP, SOIC	\$0.36
TLV2370	Wide Supply Range, General Purpose	1, 2, 4	Y	2.7	15	0.66	3	2.4	4.5	2	60	39	I/O	SOT-23, MSOP, SOIC, PDIP, TSSOP	\$0.47
OPAy363	1.8V, Excellent CMRR, SHDN	1, 2	Y	1.8	5.5	0.75	7	5	0.5	2	10	17	I/O	SOT-23, MSOP, SOIC	\$0.60
OPAy364	1.8V, Excellent CMRR, Low V_{OS}	1, 2, 4	N	1.8	5.5	0.75	7	5	0.5	2	10	17	I/O	SOT-23, MSOP, SOIC, TSSOP	\$0.60
OPAy734	12V Auto-Zero Precision Amp w/SHDN	1, 2	Y	2.7	12	0.75	1.5	1.5	0.01	0.1	100	60	Out	SOT-23, MSOP, SOIC	\$1.25
OPAy735	12V Auto-Zero Precision Amp in SOT23	1, 2	N	2.7	12	0.75	1.5	1.5	0.01	0.1	100	60	Out	SOT-23, MSOP, SOIC	\$1.25
TLV2470	Low Power, Low Bias Current, 35mA Drive	1, 2, 4	Y	2.7	6	0.75	2.8	1.4	2.2	0.4	50	15	I/O	SOT-23, MSOP(PP), PDIP, SOIC, TSSOP(PP)	\$0.65
TLV2780	1.8V Operation, Low Power Bandwidth	1, 2, 4	Y	1.8	3.6	0.82	8	4.3	3	8	15	18	I/O	SOT-23, MSOP, PDIP, SOIC, TSSOP	\$0.70
OPA337	120dB A_{OL} , FET-input	1	N	2.7	5.5	1	3	1.2	3	2	10	26	Out	SOT-23, MSOP, SOIC, PDIP	\$0.43
OPA338	Good Speed/Power, $G \geq 5$	1	N	2.7	5.5	1	12.5	4.6	3	2	10	26	Out	SOT-23, MSOP, SOIC, PDIP	\$0.43
Low Voltage, Wide Bandwidth GBW $\geq 5\text{MHz}$															
TLV246x	Low Noise, 25mA Drive	1, 2, 4	Y	2.7	6	0.575	5.2	1.6	2	2	14000	11	I/O	SOT-23, MSOP, PDIP, SOIC, TSSOP	\$0.65
OPAy340	Very Low Offset, Wide Bandwidth	1, 2, 4	N	2.7	5.5	0.95	5.5	6	0.5	2.5	10	25	I/O	SOT-23, MSOP, PDIP, SOIC	\$0.80
OPAy341	Wide Bandwidth, Single Supply	1, 2	Y	2.7	5.5	1	5.5	6	6	2	10	25	I/O	SOT-23, MSOP, SOIC	\$0.74
OPAy374	Low Cost CMOS, General Purpose	1, 2, 4	N	2.3	5.5	0.75	6.5	5	5	3	10	15	I/O	SOT-23, MSOP, SOIC, TSSOP	\$0.39
OPAy373	Shutdown Version of OPA374	1, 2	Y	2.3	5.5	0.75	6.5	5	5	3	10	15	I/O	SOT-23, MSOP, SOIC, TSSOP	\$0.39
OPAy363	1.8V, Excellent CMRR, SHDN	1, 2	Y	1.8	5.5	0.75	7	5	0.5	2	10	17	I/O	SOT-23, MSOP, SOIC	\$0.55
OPAy364	1.8V, Excellent CMRR, Low V_{OS}	1, 2, 4	N	1.8	5.5	0.75	7	5	0.5	2	10	17	I/O	SOT-23, MSOP, SOIC, TSSOP	\$0.55
TLV278x	1.8V Operation, Low Power Bandwidth, Low Noise	1, 2, 4	Y	1.8	3.6	0.82	8	4.3	3	8	15	18	I/O	SOT-23, MSOP, SOIC, TSSOP	\$0.65
TLV263x	Wide Bandwidth, CMOS	1, 2, 4	Y	2.7	5.5	1	9	6	3.5	3	50	50	Out	SOT-23, MSOP, SOIC, TSSOP	\$0.40
OPAy380	Precision, 80MHz, TIA	1, 2	2.7	5.5	1	85	80	0.025	0.1	50	—	5 at 1MHz	Out	MSOP, SOIC, SSOP	\$1.95
OPAy381	Precision, 18MHz, TIA	1, 2	2.7	5.5	1	18	12	0.025	0.1	50	—	5 at 1MHz	Out	MSOP, DFN	\$1.45
OPAy350	Excellent ADC Driver, Low Noise, Good AC and DC Performance	1, 2, 4	N	2.7	5.5	7.5	38	22	0.5	4	10	5	I/O	MSOP, SOIC, SSOP	\$1.23
OPA353	Good ADC Driver, Low THD+N	1, 2, 4	N	2.7	5.5	8	44	22	8	5	10	18	I/O	SOT-23, SOIC, MSOP, TSSOP	\$1.05
OPAy357	High Speed, SHDN	1, 2	Y	2.5	5.5	6	100	150	8	4	50	6.5	I/O	SOT-23, SOIC, MSOP	\$0.69
OPAy354	Excellent AC Performance	1, 2, 4	N	2.5	5.5	6	100	150	8	4	50	6.5	I/O	SOT-23, SOIC, MSOP, TSSOP	\$0.69

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.



Low-Voltage Operational Amplifiers/Low-Supply Current

Low-Voltage Operational Amplifiers ($V_S \leq 2.7$) Selection Guide

Device	Description	Ch.	SHDN	V_S (V) (min)	V_S (V) (max)	I_Q Per Ch. (mA) (max)	GBW (MHz) (typ)	Slew Rate (V/ μ s) (typ)	V_{OS} (25°C) (mV) (max)	Offset Drift (μ V/°C) (typ)	I_B (pA) (max)	V_N at 1kHz (nV/ \sqrt{Hz}) (typ)	Rail- to- Rail	Package(s)	Price ¹
Low Voltage, Wide Bandwidth GBW ≥ 5 MHz (Continued)															
OPA358	3V Video Amp in SC70	1	Y	2.7	3.3	6.5	80	55	6	5	50	5.8	Out	SC-70	\$0.45
OPAy300	Very Low Noise, 150ns Settling to 16-Bits	1	Y	2.7	5.5	12	180	80	5	2.5	5	3	Out	SOT-23, SOIC	\$1.25
OPAy355	High Bandwidth and Slew Rate	1, 2, 3	Y	2.5	5.5	11	200	300	9	7	50	5.8	Out	SOT-23, SOIC, MSOP, TSSOP	\$0.90
OPAy356	CMOS, 200MHz, SS	1, 2	N	2.5	5.5	11	200	300	9	7	50	5.8	Out	SOT-23, SOIC, MSOP	\$0.90

¹ Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**.Low-Supply Current Operational Amplifiers ($I_Q \leq 1$ mA) Selection Guide

Device	Description	Ch.	SHDN	V_S (V) (min)	V_S (V) (max)	I_Q Per Ch. (mA) (max)	GBW (MHz) (typ)	Slew Rate (V/ μ s) (typ)	V_{OS} (25°C) (mV) (max)	Offset Drift (μ V/°C) (typ)	I_B (pA) (max)	V_N at 1kHz (nV/ \sqrt{Hz}) (typ)	Rail- to- Rail	Package(s)	Price ¹
Low Voltage $V_S \leq 2.7$ V (min)															
TLC1078	Low Voltage, Precision	2	N	1.4	16	0.017	0.085	0.032	0.45	1.1	600	68	—	SOIC, SOP, PDIP	\$2.30
OPAy349	1 μ A, CMOS, SS	1, 2	N	1.8	5.5	0.002	0.07	0.02	10	10	15	300	I/O	SC70, SOIC, SOT23, SOT23-8 (D)	\$0.75
OPAy363	1.8V, High CMRR, SS	1, 2	Y	1.8	5.5	0.75	7	5	0.5	2	10	17	I/O	MSOP, SOIC, SOT23	\$0.60
OPAy364	1.8V, High CMRR, SS	1, 2, 4	N	1.8	5.5	0.75	7	5	0.5	2	10	17	I/O	MSOP, SOIC, SOT23, TSSOP	\$0.60
OPAy348	High Open-Loop Gain, CMOS, SS	1, 2, 4	N	2.1	5.5	0.065	1	0.5	5	2	10	35	I/O	SC70, SOIC, SOT23, SOT23-8 (D), TSSOP	\$0.45
OPA379	1.8V, Ultra-Low Power, Low Offset	1, 2, 4	N	1.8	5.5	0.0045	0.1	0.03	1	4	10	100	I/O	SC-70, SOT-23, MSOP	\$0.70
OPAy336	CMOS, μ Power, SS	1, 2, 4	N	2.3	5.5	0.032	0.1	0.03	0.125	1.5	10	40	Out	MSOP, PDIP, SOIC, SOT23	\$0.40
OPAy347	μ Power, Low Cost, CMOS, SS	1, 2, 4	N	2.3	5.5	0.034	0.35	0.17	6	2	10	60	I/O	PDIP, SC70, SOIC, SOT23, SOT23-8 (D), TSSOP	\$0.48
OPAy380	Precision, 80MHz, TIA	1, 2	Y	2.7	5.5	1	85	80	0.025	0.1	50	5 at 1MHz	Out	MSOP, SOIC, SSOP	\$1.95
OPAy381	Precision, 18MHz, TIA	1, 2	Y	2.7	5.5	1	18	12	0.025	0.1	50	5 at 1MHz	Out	MSOP, DFN	\$1.45
OPAy374	Low Voltage, Low Cost CMOS, SS	1, 2, 4	N	2.3	5.5	0.65	5	5	5	2	10	20	I/O	SOT23, TSSOP, SOIC	\$0.36
OPAy373	Low Voltage, Low Cost CMOS, SS	1, 2	Y	2.3	5.5	0.65	5	5	5	2	10	20	I/O	SOT23, MSOP, SOIC	\$0.36
OPAy244	μ Power, SS, Low Cost	1, 2, 4	N	2.6	36	0.05	0.24	0.1	1.5	4	—25000	22	N	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.55
TLV240x	2.5V, Sub- μ Power, SS	1, 2, 4	N	2.5	16	0.00095	0.0055	0.0025	1.2	3	300	800	I/O	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.80
TLV224x	Low Voltage, 1 μ A, SS	1, 2, 4	N	2.5	12	0.0012	0.0055	0.002	3	3	500	800	I/O	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.60
TLV245x	μ Power, SS	1, 2, 4	Y	2.7	6	0.035	0.22	0.12	1.5	0.3	5000	51	I/O	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.60
OPAy251	μ Power, Precision	1, 2, 4	N	2.7	36	0.038	0.035	0.01	0.25	0.5	—20000	45	Out	PDIP, SOIC	\$1.15
OPAy241	Bipolar, μ Power, High CMRR	1, 2, 4	N	2.7	36	0.025	0.35	0.1	0.25	0.4	2000	45	Out	PDIP, SOIC	\$1.15
OPAy334	Zero Drift, Precision, CMOS, SS	1, 2	Y	2.7	5.5	0.35	2	0.5	0.005	0.02	200	—	Out	MSOP, SOIC, SOT23	\$1.00
OPAy335	Zero Drift, Precision, CMOS, SS	1, 2	N	2.7	5.5	0.35	2	0.5	0.005	0.02	200	—	Out	MSOP, SOIC, SOT23	\$1.00
TLV246x	Low Noise, SS, Wide Bandwidth, 25mA Drive	1, 2, 4	Y	2.7	6	0.575	5.2	1.6	2	2	14000	11	I/O	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.60
OPAy734	12V Auto-Zero Precision Amp with Shutdown	1, 2	Y	2.7	12	0.75	1.5	1.5	0.01	0.1	100	60	Out	SOT23, MSOP, SOIC	\$1.25
OPAy735	12V, High-Precision Amp	1, 2	N	2.7	12	0.75	1.5	1.5	0.01	0.1	100	60	Out	SOT23, MSOP, SOIC	\$1.25
OPAy340	CMOS, Wide Bandwidth	1, 2, 4	N	2.7	5.5	0.95	5.5	6	0.5	2.5	10	25	I/O	MSOP, PDIP, SOIC	\$0.80
Low-Supply Current, Wide Bandwidth GBW ≥ 5 MHz (typ)															
TLV247x	Low Power, SS, Low Bias Current, 35mA Drive	1, 2, 4	Y	2.7	6	0.75	2.8	1.4	2.2	0.4	50	15	I/O	MSOP (PP), PDIP, SOIC, SOT23, TSSOP (PP)	\$0.60
OPA374	Low Voltage, Low Cost CMOS, SS	1, 2, 4	N	2.3	5.5	0.65	5	5	5	2	10	20	I/O	SOT23, TSSOP, SOIC	\$0.36
OPA373	Low Voltage, Low Cost CMOS, SS	1, 2	Y	2.3	5.5	0.65	5	5	5	2	10	20	I/O	SOT23, MSOP, SOIC	\$0.36
TLV246x	Low Noise, SS, Wide Bandwidth, 25mA Drive	1, 2, 4	Y	2.7	6	0.575	5.2	1.6	2	2	14000	11	I/O	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.60

¹ Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.

Low-Supply Current/Wide-Voltage Range Operational Amplifiers

Low-Supply Current Operational Amplifiers ($I_Q \leq 1\text{mA}$) Selection Guide (Continued)

Device	Description	Ch.	SHDN	V_S (V) (min)	V_S (V) (max)	I_Q Per Ch. (mA) (max)	GBW (MHz) (typ)	Slew Rate (V/ μ s) (typ)	V_{OS} (25°C) (mV) (max)	Offset Drift (μ V/°C) (typ)	I_B (pA) (max)	V_N at 1kHz (nV/ $\sqrt{\text{Hz}}$) (typ)	Rail- to- Rail	Package(s)	Price ¹
Low-Supply Current, Wide Bandwidth GBW $\geq 5\text{MHz}$ (typ) (Continued)															
OPAy340	CMOS, Wide Bandwidth, SS	1, 2, 4	N	2.7	5.5	0.95	5.5	6	0.5	2.5	10	25	I/O	MSOP PDIP, SOIC, SOT23, TSSOP	\$0.80
OPAy341	Low Voltage, Wide Bandwidth, SS	1, 2	Y	2.7	5.5	1	5.5	6	6	2	10	25	I/O	MSOP, SOIC, SOT23	\$0.75
OPAy363	1.8V, High CMRR, SS	1, 2	Y	1.8	5.5	0.75	7	5	0.5	2	10	17	I/O	MSOP, SOIC, SOT23	\$0.60
OPAy364	1.8V, High CMRR, SS	1, 2, 4	N	1.8	5.5	0.75	7	5	0.5	2	10	17	I/O	MSOP, SOIC, SOT23, TSSOP	\$0.60
TLV278x	1.8V, Low Power, SS, 8MHz, Low Bias Current	1, 2, 4	Y	1.8	3.6	0.82	8	4.3	3	8	15	18	I/O	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.65
TLV263x	1mA/Ch, 9MHz, V_{IN} to GND, SS	1, 2, 4	Y	2.7	5.5	1	9	6	3.5	3	50	50	Out	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.65
OPA358	3V Video Amp in SC70	1	Y	2.7	3.3	6.5	70	70	9	4	50	5.8	Out	SC70, SOT23	\$0.45
OPAy380	Precision, 80MHz, TIA	1, 2	Y	2.7	5.5	1	85	80	0.025	0.1	50	5 at 1MHz	Out	MSOP, SOIC, SSOP	\$1.95
OPAy381	Precision, 18MHz, TIA	1, 2	Y	2.7	5.5	1	18	12	0.025	0.1	50	5 at 1MHz	Out	MSOP, DFN	\$1.45

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in bold red.

Wide-Voltage Range Operational Amplifiers ($\pm 5\text{V} \leq V_S \leq \pm 20\text{V}$) Selection Guide

Device	Description	Ch.	V_S (V) (min)	V_S (V) (max)	I_Q Per Ch. (mA) (max)	GBW (MHz) (typ)	Slew Rate (V/ μ s) (typ)	V_{OS} (25°C) (mV) (max)	Offset Drift (μ V/°C) (typ)	I_B (pA) (max)	CMRR (dB) (min)	V_N at 1kHz (nV/ $\sqrt{\text{Hz}}$) (typ)	Single Supply	Rail- to- Rail	Package(s)	Price ¹
OPA124	Low Noise, Precision	1	10	36	7.5	1.5	1.6	0.25	2	1	100	8	N	N	PDIP	\$3.95
OPAy703	12V, CMOS, Low Power	1, 2, 4	4	12	0.2	1	0.6	0.75	4	10	70	45	Y	I/O	MSOP, SOIC	\$1.30
OPAy704	12V, CMOS, Low Power	1, 2, 4	4	12	0.2	3	3	0.75	4	10	70	45	Y	I/O	MSOP, SOIC	\$1.30
OPAy705	12V, CMOS, Low Power	1, 2, 4	4	12	0.2	1	0.6	5	4	10	66	45	Y	I/O	MSOP, SOIC	\$1.60
OPAy734	12V, Auto-Zero Precision	1, 2	2.7	12	0.75	1.6	1.5	0.005	0.05	200	115	150	Y	Out	SOT23, MSOP	\$1.25
OPAy735	12V, High-Precision Amp	1, 2	2.7	12	0.75	1.6	1.5	0.005	0.05	200	115	150	Y	Out	SOT23, MSOP	\$1.25
OPAy743	12V, 7MHz, CMOS	1, 2, 4	3.5	12	1.5	7	10	7	8	10	66	30	Y	I/O	MSOP, SOIC	\$0.95
OPAy725	Very Low Noise	1, 2	3.5	13.2	5.5	20	30	3	4	200	88	6	Y	Out	SOT23, MSOP	\$0.90
OPAy726	Very Low Noise, Shutdown	1, 2	3.5	13.2	5.5	20	30	3	4	200	88	6	Y	Out	SOIC	\$0.90
OPAy727/8	20MHz e-trim™ Precision CMOS	1, 2, 4	2.5	12	5	25	50	0.5	2	10	92	10	Y	I	MSOP, DFN	\$1.45
TLV237x	550 μ A, 3MHz, SHDN	1, 2, 4	2.7	15	0.66	3	2.4	4.5	2	60	57	39	Y	I/O	SOT23, MSOP	\$0.43
TLV238x	Low Power, RRIO	1, 2	2.7	16	0.01	0.16	0.05	6.5	1.1	60	72	90	Y	I/O	SOT, MSOP	\$0.60
TLC220x	Precision, Low Noise	1, 2	4.6	16	1.5	1.8	2.5	0.5	0.5	100	85	8	Y	Out	PDIP, SOIC	\$1.65
TLV240x	2.5V, 1 μ A Amplifier	1, 2, 4	2.5	16	0.00095	0.0055	0.0025	1.2	3	300	63	800	Y	I/O	MSOP, SOIC	\$0.80
TLC07x	Low Noise, Wide Bandwidth	1, 2, 4	4.5	16	2.5	10	16	1	1.2	50	100	7	Y	N	MSOP (PP)	\$0.45
TLC08x	Low Noise, Wide Bandwidth	1, 2, 4	4.5	16	2.5	10	16	1	1.2	50	100	8.5	Y	N	MSOP (PP)	\$0.45
OPA627	Ultra-Low THD+N,	1	9	36	7.5	16	55	0.25	2	5	106	5.2	N	N	PDIP, SOIC	\$12.25
OPA637	Ultra-Low THD+N, $G \geq 5$	1	9	36	7.5	80	46	0.25	2	5	106	8	N	N	PDIP, SOIC	\$12.25
OPAy130	Low Power, FET-Input	1, 2, 4	4.5	36	0.65	1	100	1	2	20	90	16	N	N	SOIC	\$1.40
OPAy131	General Purpose, FET Input	1, 2, 4	4.5	36	1.75	4	10	1	2	50	80		N	N	PDIP, SOIC	\$0.75
OPAy132	Wide Bandwidth, FET-Input	1, 2, 4	5	36	4.5	8	20	0.5	2	50	96	8	N	N	PDIP, SOIC	\$1.45
OPAy134	Audio, Wide Bandwidth	1, 2, 4	5	36	5	8	20	2	2	100	86	8	N	N	PDIP, SOIC	\$0.95
OPAy137	Low Cost, FET-Input	1, 2, 4	5	36	0.25	1	3	4	2	100	76	45	Y	N	PDIP, SOIC	\$0.60
OPAy227	Precision, Low Noise	1, 2, 4	5	36	3.8	8	2.3	0.075	0.6	10000	120	3	N	N	PDIP, SOIC	\$1.10
OPAy228	Precision, Low Noise, $G \geq 5$	1, 2, 4	5	36	3.8	33	11	0.075	0.6	10000	120	3	N	N	PDIP, SOIC	\$1.10
OPAy234	Low Power, Precision	1, 2, 4	2.7	36	0.35	0.35	0.2	0.1	0.5	-30000	91	25	Y	N	MSOP, SOIC	\$1.05
OPAy237	Low Cost, Low Power	1, 2	2.7	36	0.48	1.4	0.5	0.95	2	-40000	78	28	Y	N	MSOP, SOIC	\$0.55
OPAy241	μ Power, Precision	1, 2, 4	2.7	36	1.038	0.035	0.01	0.25	0.5	-20000	100	45	Y	Out	PDIP, SOIC	\$1.15

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in bold red.



Wide-Voltage Range Operational Amplifiers

Wide Voltage Range Operational Amplifiers ($\pm 5V \leq V_S \leq \pm 20V$) Selection Guide (Continued)

Device	Description	Ch.	V _S (V) (min)	V _S (V) (max)	I _Q Per Ch. (mA) (max)	GBW (MHz) (typ)	Slew Rate (V/ μ s) (typ)	V _{OS} (25°C) (mV) (max)	Offset Drift (μ V/°C) (typ)	I _B (pA) (max)	CMRR (dB) (min)	V _N at 1kHz (nV/ \sqrt Hz) (typ)	Single Supply	Rail- to- Rail	Package(s)	Price ¹
OPAy244	μ Power, Low Cost	1, 2, 4	2.6	36	0.06	0.43	0.1	1.5	4	-25000	84	22	Y	N	MSOP, SOIC	\$0.55
OPAy251	μ Power, Precision	1, 2, 4	2.7	36	0.038	0.035	0.01	0.25	0.5	-20000	100	45	Y	Out	PDIP, SOIC	\$1.15
OPAy277	High Precision, Low Power	1, 2, 4	4	36	0.825	1	0.8	0.02	0.1	1000	130	8	N	N	PDIP, SOIC	\$0.85
TLE206x	Low Power, FET-Input	1, 2, 4	7	36	0.35	2	3.4	3	6	2000	65	40	N	N	PDIP, SOIC	\$0.65
TLE2027	Precision, Low Noise	1	8	38	5.3	13	2.8	0.1	0.4	90000	100	2.5	N	N	SOIC	\$0.90
TLE202x	Low Power	1, 2, 4	4	40	0.3	1.2	0.5	0.6	2	70000	85	17	Y	N	PDIP, SOIC	\$0.45

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Industry Standard Operational Amplifiers Selection Guide

Device	Description	Ch.	V _S (V) (min)	V _S (V) (max)	I _Q Per Ch. (mA) (max)	GBW (MHz) (typ)	Slew Rate (V/ μ s) (typ)	V _{OS} (25°C) (mV) (max)	Offset Drift (μ V/°C) (typ)	I _B (pA) (max)	CMRR (dB) (min)	V _N at 1kHz (nV/ \sqrt Hz) (typ)	Single Supply	Package(s)	Price ¹
LF353	JFET-Input	2	7	36	3.25	3	13	10	10	0.2	70	18	N	PDIP, SOIC	\$0.23
LM2904	General Purpose	2	3	26	0.6	0.7	0.3	7	7	-250	50	40	Y	PDIP, SO, SOP, TSSOP	\$0.10
LM2902	General Purpose	4	3	26	0.3	1.2	0.5	7	—	-250	50	35	Y	PDIP, SO, SOP, TSSOP	\$0.10
LM358/358A	General Purpose	2	3	32	0.6	0.7	0.3	3	7	-250	65	40	Y	PDIP, SO, MSOP, SOP	\$0.12
LM324/324A	General Purpose	4	3	32	0.3	1.2	0.5	3	—	-250	65	35	Y	SSOP, TSSOP	\$0.17
LMV321	Low Voltage, RRO	1	2.7	5.5	0.17	1	1	7	5	250	50	39	Y	SOT23, SC70	\$0.20
LMV824	Low Voltage, RRO	4	2.7	5.5	0.325	5.3	2.5	3.5	1	100	72	42	Y	SOIC, TSSOP	\$0.43
LPV324	Low Voltage, RRO	4	2.7	5.5	0.0105	250	0.1	7	4	50	50	146	Y	SOIC, TSSOP	\$0.32
LMV358	Low Voltage, RRO	2	2.7	5.5	0.17	1	1	7	5	250	50	39	Y	MSOP, SOIC, TSSOP	\$0.29
LMV324/S	Low Voltage, RRPO	4	2.7	5.5	0.17	1	1	7	5	250	50	39	Y	SOIC, TSSOP	\$0.29
LT1013	Precision, Low Power	2	4	44	0.55	1	0.4	0.3	2.5	-30	97	22	Y	PDIP, CDIP, LCCC	\$0.97
LT1013D	Precision, Low Power	2	4	44	0.55	1	0.4	0.8	5	-30	97	22	Y	PDIP, SOIC	\$0.77
LT1014	Precision, Low Power	4	4	44	0.55	1	0.4	0.3	2.5	-30	97	2	Y	PDIP, CDIP, LCCC	\$3.55
LT1014D	Precision, Low Power	4	4	44	0.55	1	0.4	0.8	5	-30	97	22	Y	PDIP, Wide SOIC	\$2.94
MC1458	General Purpose	2	10	30	2.8	1	0.5	6	—	500	70	45	N	PDIP, SOIC, SOP	\$0.15
MC3403	Low Power	4	5	30	1.75	1	0.6	10	10	-500	70	—	Y	PDIP, SOIC, SOP, TSSOP	\$0.23
NE5532/A	Low Noise, Audio	2	10	30	8	10	9	4	—	800	70	5	N	PDIP, SOIC, SOP	\$0.45
NE5534/A	Low Noise, Audio	1	10	30	8	10	13	4	—	800	70	3.5	N	PDIP, SOIC, SOP	\$0.58
OP07C/D	Precision, Low Offset	1	6	36	5	0.6	0.3	0.15	0.5/0.7	12	100/94	9.8	N	PDIP, SOIC, SOP	\$0.47
RC4558	Audio	2	10	30	2.8	3	1.7	6	—	500	70	8	N	PDIP, SO, SOP, TSSOP	\$0.29
RC4559	Audio	2	—	36	2.8	4	2	6	—	250	80	—	N	PDIP, SO, SOP, TSSOP	\$0.40
RC4580	Audio	2	4	32	9	12	5	3	—	500	80	6	N	PDIP, SOIC, TSSOP	\$0.40
TL06x/A/B	Low Power, JFET-Input	1, 2, 4	7	36	0.25	1	3.5	15, 6, 3	10	0.4, 0.2, 0.2	70, 80, 80	42	N	PDIP, SOIC, SOP, TSSOP, CDIP, CFP	\$0.25
TL07x/A/B	Low Noise, JFET-Input	1, 2, 4	7	36	2.5	3	13	10, 6, 3	18	0.2	70, 75, 75	18	N	PDIP, SOIC, SOP, TSSOP, CDIP, CFP, LCCC	\$0.18
TL08x/A/B	JFET-Input	1, 2, 4	7	36	2.8	3	13	15, 6, 3	18	0.4, 0.2, 0.2	70, 75, 75	18	N	PDIP, SOIC, SOP, TSSOP, CDIP, LCCC	\$0.20
TL343	Single, Low Power	1	5	36	2.8	1	1	10	10	50	70	—	Y	SOT23-5	\$0.36
TL3472	High Slew Rate	2	4	36	4.5	4	13	10	10	500	65	49	Y	MSOP, PIP, SOIC	\$0.45
TL3474/A	High Slew Rate	4	4	36	4.5	4	13	10, 3	10	500	80	49	Y	PDIP, SOIC, TSSOP	\$0.67
TLV236x	Low Voltage, RRO	1, 2	2	5	2.5	7	3	6	—	150	85	8	N	MSOP, PDIP, SOT23, SOIC, TSSOP	\$0.36
UA747/747	General Purpose	1, 2	7	36	2.8	1	0.5	6	—	500	70	—	N	PDIP, SOIC, SOP	\$0.18

¹Suggested resale price in U.S. dollars in quantities of 1,000.

High-Speed Amplifiers



TI develops high-speed signal conditioning products using state-of-the-art processes that give leading-edge performance. Used in high-speed signal chains and analog-to-digital drive circuits, high-speed amps are broadly defined as any amplifier having at least 50MHz of bandwidth and at least 100V/ μ s slew rate. High-speed amps from TI come in several different types and supply voltage options.

Design Considerations

Voltage-feedback type—the most commonly used amp and the basic building block of most analog signal chains such as gain blocks, filtering, level shifting, buffering, etc. Most voltage-feedback amps are unity-gain stable, though some are decompensated to provide wider bandwidth, faster slew rate and lower noise.

Current-feedback type—most commonly seen in video or DSL line driver applications, or designs where extremely fast slew rate is needed.

Fully differential amplifier (FDA)—the fully differential input and output topology

has the primary benefit of reducing even order harmonics, thereby reducing total harmonic distortion. The FDA also rejects common-mode components in the signal and provides a larger output swing to the load relative to single-ended amplifiers. Fully differential amplifiers are well-suited to driving analog-to-digital converters. A V_{COM} pin sets the output common-mode voltage required by newer ADCs.

FET-Input (or CMOS) amplifiers—have higher input impedance than typical bipolar amps and are more useful to interfacing to high impedance sources, such as photodiodes in transimpedance circuits.

Video amplifiers—can be used in a number of different ways, but generally are in the signal path for amplifying, buffering, filtering or driving video lines. The specifications of most interest are differential gain and differential phase. Current-feedback amps are typically used in video applications, because of their combination of high slew rate and excellent output drive at low quiescent power.

Fixed and variable gain—these amps have either a fixed gain, or a variable gain that can be set either digitally with a few control pins, or linearly with a control voltage. Fixed-gain amplifiers are fixed internally with gain setting resistors. Variable gain amplifiers can have different gain ranges, and can also be differential input and/or output.

Packaging—high-speed amplifiers typically come in surface-mount packages, because parasitics of DIP packages can limit performance. Industry standard surface-mount packages (SOIC, MSOP, TSSOP and SOT23) handle the highest speed requirements. For bandwidths approaching 1GHz and higher, the QFN package decreases inductance and capacitance.

Evaluation boards—high-speed amps have an associated Evaluation Module (EVM). EVMs are a very important part of high-speed amplifier evaluation, since layout is a critical to design success. To make layout simple, Gerber files for the EVMs are available. See page 107 for more information.

Voltage Feedback			Current Feedback	
High-Speed < 500MHz (GBW Product)	FET or CMOS Input	Low Noise $\leq 3nV/\sqrt{Hz}$	General Purpose +5V to $\pm 5V$ Operational	
<ul style="list-style-type: none"> THS4001 THS4011/4012 THS4051/4052 THS4061/4062 THS4081/4082 THS4041/4042 OPA820/OPA4820 OPA2613 OPA2614 OPA842 OPA2652 OPA2822 THS4271 OPA690/2690/3690 	<ul style="list-style-type: none"> OPA656 OPA657 (G > 7) THS4601 OPA355/2355/3355 OPA356/2356 OPA354/2354/4354 OPA357/2357 OPA358/OPA360 OPA300/OPA2300 OPA301/OPA2301 THS4631 OPAy380/OPA2380 OPAy381/OPA2381 	<ul style="list-style-type: none"> THS4021/4022 (G ≥ 10) THS4031/4032 (G ≥ 2) OPA2822 THS4130/4131 THS4271 OPA300/OPA301 OPA820/OPA4820 OPA842 OPA843 (G > 3) OPA846/OPA2846 (G > 7) OPA847 (G > 12) OPA358 OPA820/OPA4820 	<ul style="list-style-type: none"> OPA683/2683 OPA684/2684/3684/4684 OPA691/2691/3691 OPA692/3692 (G = 2 or ± 1) OPA2677 THS3201/02 OPA694/OPA2694 OPA2674 	
Fully Differential	Low Voltage $\leq 3.3V$	Variable Gain	General Purpose $\pm 5V$ to $\pm 15V$ Operational	
<ul style="list-style-type: none"> THS4120/4121 THS4130/4131 THS4140/4141 THS4150/4151 THS4500/4501 THS4502/4503 THS4504/4505 THS4509 	<ul style="list-style-type: none"> THS4120/21 OPA355/2355/3355 OPA356/2356 THS4222/4226 OPA354/2354/4354 OPA357/2357 OPA300/OPA2300 OPA301/OPA2301 OPA358/OPA360 OPA830/OPA2830 OPA832/OPA2832 	<ul style="list-style-type: none"> THS7001/02 THS7530 VCA2612/2613/2614/2616/2618 VCA810 VCA811 VCA8613/VCA8617 VCA2615/VCA2617 	<ul style="list-style-type: none"> THS3001 THS3112/15 THS3122/25 THS3061/3062 THS3110/11 THS3120/1 THS3091/95 THS3092/96 THS6184 	
Very High-Speed > 500MHz (GBW Products)	Rail-to-Rail Input or Output	Voltage Limiting Output	Very High-Speed > 500MHz	
<ul style="list-style-type: none"> OPA843 OPA847 OPA846/OPA2846 THS4271 THS4302 THS4211/4215 	<ul style="list-style-type: none"> OPA355/2355/3355 OPA356/2356 THS4222/4226 OPA354/2354/4354 OPA357/2357 OPA358/OPA360 OPA830/OPA2830 OPA832/OPA2832 	<ul style="list-style-type: none"> OPA698 OPA699 (G ≥ 4) 	<ul style="list-style-type: none"> OPA695 THS3201/THS3202 OPA694/OPA2694 	

Preview devices appear in BLUE.
New devices appear in RED.

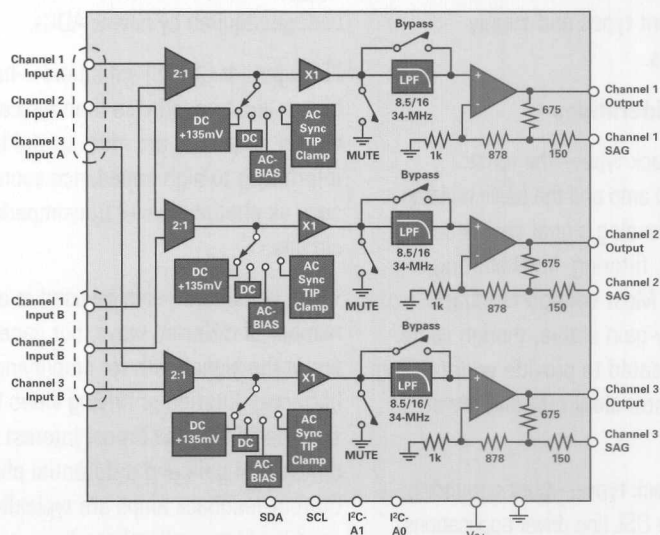
High-speed amplifiers selection tree.

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/THS7303

- 2:1 input MUX
- 2.7V to 5V operation
- Selectable 5-pole low pass filter:
 - 8.5MHz (480i/576i/NTSC/PAL)
 - 16MHz (480p/576p/VGA)
 - 34MHz (720p/1080i/VGA/XGA)
- Selectable input: DC/DC + 135mV/AC-internal bias/AC-sync tip clamp
- +6dB gain + SAG correction if desired
- Mute capability
- I^2C control with selectable addressing
- Total quiescent current:
16-mA (53mW at 3.3V)
- Quiescent current in shutdown: 0.1 μ A
- RRO and VICR includes ground
- Packaging: 4mm x 4mm QFN-20,
TSSOP-20

- Set-top-box output video buffering
- DVDR/PVR output buffering
- USB/Portable low power video buffering

The THS7303 is a low power single-supply 3-channel integrated video buffer. The THS7303 features a 5th-order selectable filter for elimination of data converter images and is a perfect choice for SDTV video. Each channel is individually two-wire I²C configurable for all functions, making it flexible for any video buffering application.



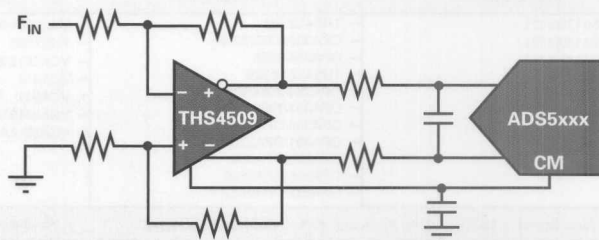
THS7303 functional block diagram.

Get samples, datasheets, EVMs and app reports at: www.ti.com/THS4509

- Bandwidth: 1900MHz
- Slew rate: 6600V/ μ s
- 1% settling time: 2ns
- Input voltage noise: $1.9\text{nV}/\sqrt{\text{Hz}}$
($f > 10\text{MHz}$)
- Noise figure: 17dB
- Output common-mode control
- Power supply:
 - Voltage: 3V ($\pm 1.5\text{V}$) 5V ($\pm 2.5\text{V}$)
 - Current: 37.7mA
- Power-down capability: 0.65mA

- 5V data acquisition systems
- High-linearity ADC amplifiers
- Wireless communication
- Medical imaging
- Test and measurement

The THS4509 is a wideband, fully differential op amp designed for 3V to 5V data acquisition systems. It has very low noise at $1.9\text{nV}/\sqrt{\text{Hz}}$, and extremely low harmonic distortion of -75dBc HD_2 and -80dBc HD_3 at 100MHz with 2Vpp , $G = 10\text{dB}$ and $1\text{k}\Omega$ load. Slew rate is very high at $6600\text{V}/\mu\text{s}$ and with settling time of 2ns to 1% (2V step) it is ideal for pulsed applications. It is designed for minimum gain of 6dB , but is optimized for gain of 10dB .



THS4509 functional block diagram.

High-Speed Amplifiers Selection Guide

Device	Ch.	SHDN	Supply Voltage (V)	A _{CL} (min)	BW at A _{CL} (MHz) (typ)	BW G = +2 (MHz) (typ)	GBW Product (MHz) (typ)	Slew Rate (V/μs)	Settling Time 0.1% (ns) (typ)	Distortion			Differential		V _N (nV/√Hz) (typ)	V _{OS} (mV) (max)	I _B (μA) (max)	I _Q Per Ch. (mA) (typ)	I _{OUT} (mA) (typ)	Package(s)	Price ¹
										THD 2V _{pp} G = 1 1MHz (dB) (typ)	1V _{pp} , G = 2, 5MHz										
											HD2 (dBc) (typ)	HD3 (dBc) (typ)	Gain (%)	Phase (°)							
Fully Differential																					
THS4120/21	1	Y	3.0 to 3.6	1	100	—	—	55	60	−75	−70	−60	—	—	5.4	8	1.2pA	11	100	SOIC, MSOP PowerPAD™	\$1.90
THS4130/31	1	Y	5, ±5, ±15	1	150	90	90	52	78	−97	−60	−75	—	—	1.3	2	6	12.3	85	SOIC, MSOP PowerPAD	\$3.50
THS4140/41	1	Y	5, ±5, ±15	1	160	—	—	450	96	−79	−65	−55.5	—	—	6.5	7	15	15	85	SOIC, MSOP PowerPAD	\$3.40
THS4150/51	1	Y	5, ±5, ±15	1	150	81	100	650	53	−84	−72	−73	—	—	7.6	7	15	17.5	85	SOIC, MSOP PowerPAD	\$4.70
THS4500/01	1	Y	5, ±5	1	370	175	300	2800	6.3	−100	−82	−97	—	—	7	7	4.6	23	120	SOIC, MSOP PowerPAD	\$3.65
THS4502/03	1	Y	5, ±5	1	370	175	300	2800	6.3	−100	−83	−97	—	—	6	7	4.6	23	120	SOIC, MSOP PowerPAD	\$4.00
THS4504/05	1	Y	5, ±5	1	260	110	210	1800	20	−100	−79	−93	—	—	8	7	4.6	16	130	SOIC, MSOP PowerPAD	\$1.75
THS4509	1	Y	+5	2	2000	1900	3000	6600	10	−98	−75	−80	—	—	1.9	0.8	6	37.7	20	QFN	\$3.75
Fixed and Variable Gain																					
BUF634	1	N	5, ±5, ±15	1	180	—	—	2000	200	—	—	—	0.4	0.1	4	100	20	15	250	SOIC	\$3.05
OPAy692	1, 3	Y	5, ±5	1	280	225	—	2000	8	−93	−70	−74	0.07	0.02	1.7	2.5	35	5.1	190	SOT23, SOIC	\$1.15
OPA693	1	Y	5, ±5	1	1400	700	—	2500	12	−87	−74	−87	0.03	0.01	1.8	2	35	13	120	SOT23, SOIC	\$1.30
OPAy832	1, 2, 3	N	+2.8 to ±5	2	99	80	—	350	45	−64	−66	−73	0.1	0.16	9.2	7	10	4.25	120	SOIC, SOT23	\$0.70
THS4302	1	Y	3, 5	5	2400	—	12000	5500	—	—	—	—	—	—	2.8	4.25	10	37	180	Leadless MSOP PowerPAD	\$2.10
THS4303	1	Y	3, 5	10	1800	—	18000	5500	—	—	—	—	—	—	2.5	4.25	10	34	180	Leadless MSOP PowerPAD	\$2.10
THS7001	1	Y	±5, ±15	1	—	100	—	85	85	−60	−65	−65	0.02	0.01	1.7	5	6	7	50	TSSOP PowerPAD	\$3.80
THS7002	2	Y	±5, ±15	1	—	100	—	85	85	−88	−65	−65	0.02	0.01	1.7	5	6	7	50	TSSOP PowerPAD	\$6.00
THS7530	1	Y	5	4	300	—	—	1750	—	−51	−54	−50	—	—	1.27	—	30	35	20	TSSOP PowerPAD	\$3.85
CMOS Amplifiers																					
OPAx355	1, 2, 3	Y	2.5 to 5.5	1	450	100	200	300	30	—	−81	−93	0.02	0.05	5.8	9	50pA	8.3	60	MSOP	\$1.19
OPAx354	1, 2, 4	N	2.5 to 5.5	1	250	90	100	150	30	—	−75	−83	0.02	0.09	6.5	8	50pA	4.9	100	SOT23, SOIC PowerPAD	\$0.75
OPAx356	1, 2	N	2.5 to 5.5	1	450	100	200	300	30	—	−81	−93	0.02	0.05	5.8	9	50pA	8.3	60	SOT23, SOIC	\$0.85
OPAx357	1, 2	Y	2.5 to 5.5	1	250	90	100	150	30	—	−75	−83	0.02	0.09	6.5	8	50pA	4.9	100	SOT23, SOIC PowerPAD	\$0.69
OPAy300	1	Y	2.7 to 5.5	1	—	80	150	80	30	—	−74	−78	0.01	0.1	3	5	0.5	12	40	SOT-23, SOIC	\$1.25
OPAy301	1	N	2.7 to 5.5	1	—	80	150	80	30	—	−74	−78	0.01	0.1	3	5	0.5	12	40	SOP-5, SOIC-8	\$1.25
FET-Input																					
OPA656	1	N	±5	1	400	185	240	290	8	−92	−80	−89	0.01	0.01	6	2	125	25	60	SOIC	\$3.35
OPA657	1	N	±5	7	350	—	1600	700	10	−83	−73	−100	—	—	4.8	1.8	20	14	70	SOT23, SOIC	\$3.80
THS4601	1	N	±5, ±15	1	440	95	180	100	135	−76	−80	−83	0.02	0.08	5.4	4	100	10	80	SOIC	\$4.00
THS4631	1	N	+10 to ±15	1	325	105	210	1000	40	−74	−76	−94	—	—	7	0.26	0.05	11.5	98	SOP, MSOP, SOIC	\$5.00
Voltage Feedback																					
OPA2613	2	N	5, ±5	1	230	110	125	70	40	−94	—	—	—	—	1.8	1	10	6	350	SOIC	\$1.55
OPA2614	2	—	5, 12	2	180	180	290	145	35	−75	92	110	—	—	1.8	1	14.5	6.5	350	SOP, SOIC	\$1.55
OPA2652	2	N	±5	1	700	200	200	335	—	−100	−76	−66	0.05	0.03	8	7	15	5.5	140	SOT23, SOIC	\$1.34
OPA2822	2	N	5, ±5	1	400	200	240	170	32	−96	−81	−91	0.02	0.03	2	1.2	12	4.8	150	SOIC, MSOP	\$1.45

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**.

High-Speed Amplifiers Selection Guide (Continued)

Device	Ch.	SHDN	Supply Voltage (V)	A _{CL} (min)	BW at A _{CL} (MHz) (typ)	BW G = +2 (MHz) (typ)	Product GBW (MHz) (typ)	Slew Rate (V/μs)	Settling Time 0.1% (ns) (typ)	Distortion			Differential		V _N (nV/√Hz) (typ)	V _{OS} (mV) (max)	I _B (μA) (max)	I _Q Per Ch. (mA) (typ)	I _{OUT} (mA) (typ)	Package(s)	Price ¹
										THD 2Vpp G = 1 1MHz (dB) (typ)	1Vpp, G = 2, 5MHz										
											HD2 (dBc) (typ)	HD3 (dBc) (typ)	Gain (%)	Phase (°)							
Voltage Feedback (Continued)																					
OPAy830	1, 2, 4	N	+5 to ±5	1	310	120	110	600	42	−82	−71	−77	0.07	0.17	9.5	1.5	10	4.25	150	SOIC, SOT23	\$0.75
OPA842	1	N	±5, 5	1	350	150	200	400	15	−107	−100	−104	0.003	0.006	2.6	1.2	35	20.2	100	SOIC, SOT23	\$1.55
OPA843	1	N	±5, 5	3	500	—	800	1000	7.5	−105	—	—	0.001	0.012	2	1.2	35	20.2	100	SOIC, SOT23	\$1.60
OPAy846	1, 2	N	±5	7	500	—	1750	625	10	−105	—	—	0.02	0.02	1.2	0.6	19	12.6	80	SOIC, SOT23	\$1.70
OPA847	1	Y	±5, 5	12	600	—	3800	950	10	−110	—	—	—	—	0.85	0.5	39	18.1	75	SOIC, SOT23	\$2.00
OPAy690	1, 2, 3	Y	5, ±5	1	500	220	300	1800	8	−91	−78	−78	0.06	0.03	5.5	4	8	5.5	190	SOT23, SOIC	\$1.35
OPAy820	1, 4	N	+5 to ±5	1	800	240	280	240	18	−84	−90	−110	0.01	0.03	7.5	0.75	−70	5.6	110	SOP, SOIC	\$0.90
SN10501/2/3	1, 2, 3	N	±5, 5	1	230	—	120	990	25	−88	−90	−100	0.007	0.007	13	12	0.9	14	100	SOIC, SOT23	\$0.70
THS4001	1	N	5, ±5, ±15	1	270	—	100	400	40	−72	−65	−62	0.04	0.15	12.5	8	5	7.8	100	SOIC	\$2.00
THS4011/12	1, 2	N	±5, ±15	1	290	50	100	310	37	−80	−65	−80	0.006	0.01	7.5	6	6	7.8	110	SOIC, MSOP PowerPAD™	\$2.30
THS4021/22	1, 2	N	±5, ±15	10	350	—	1600	470	40	−68	−55	−83	0.02	0.08	1.5	2	6	7.8	100	SOIC, MSOP PowerPAD	\$2.20
THS4031/32	1, 2	N	±5, ±15	2	100	100	200	100	60	−72	−77	−67	0.015	0.025	1.6	2	6	8.5	90	SOIC, MSOP PowerPAD	\$2.00
THS4041/42	1, 2	N	±5, ±15	1	165	60	100	400	120	−75	−75	−88	0.01	0.01	14	10	6	8	100	SOIC, MSOP PowerPAD	\$1.65
THS4051/52	1, 2	N	±5, ±15	1	70	38	—	240	60	−82	−66	−79	0.01	0.01	14	10	6	8.5	100	SOIC, MSOP PowerPAD	\$1.10
THS4061/62	1, 2	N	±5, ±15	1	180	—	100	400	40	−72	−58	−75	0.02	0.02	14.5	8	6	7.8	115	SOIC, MSOP PowerPAD	\$1.40
THS4081/82	1, 2	N	±5, ±15	1	175	—	100	230	43	−64	−67	−52	0.01	0.05	10	7	6	3.4	85	SOIC, MSOP PowerPAD	\$1.80
THS4211/15	1	Y	5, ±5, 15	1	1000	325	350	970	22	−95	−98	−110	0.007	0.003	7	12	15	19	220	SOIC, MSOP PowerPAD	\$1.80
THS4222/26	2	Y	3, 5, ±5, 15	1	230	100	120	975	25	−100	−79	−92	0.007	0.007	13	10	3	14	100	SOIC, MSOP PowerPAD	\$1.90
THS4271/75	1	Y	5, ±5, 15	1	1400	390	400	1000	25	−110	−100	−94	0.007	0.004	3	10	15	22	160	SOIC, MSOP PowerPAD	\$2.58
THS4304	1	N	5	1	2500	—	1000	1000	5	−92	−92	−75	—	—	2.4	0.5	6	18	100	SOIC, MSOP	\$1.75
Current Feedback																					
OPA2674	2	Y	5, ±6	1	250	225	—	2000	—	−87	−73	−82	0.03	0.01	2	4.5	30	9	±500	SOIC, SOT23	\$1.80
OPA2677	2	N	5, ±12	1	220	200	—	2000	—	−87	−75	−85	0.03	0.01	2	4.54	30	9	500	SOIC, SOIC PowerPAD	\$1.75
OPA695	1	Y	5, ±5	1	1700	1400	—	4300	—	−86	−88	−95	0.04	0.007	1.8	3	30	12.9	120	SOT23, SOIC	\$1.35
OPAy683	1, 2	Y	5, ±5	1	200	150	—	540	—	−84	−70	−85	0.06	0.03	4.4	3.5	4	0.94	110	SOT23, SOIC	\$1.20
OPAy684	1, 2, 3, 4	Y	5, ±5	1	210	160	—	820	—	−77	−73	−77	0.04	0.02	3.7	3.5	35	1.7	120	SOT23, SOIC	\$1.35
OPAy691	1, 2, 3	Y	5, ±5	1	280	225	—	2100	8	−93	−77	−79	0.07	0.02	1.7	2.5	35	5.1	190	SOT23, SOIC	\$1.45
OPAy694	1, 2	N	±5	1	1500	690	—	1700	13	—	−92	−93	0.03	0.015	2.1	4.1	18	5.8	80	SOIC, SOT-23	\$1.25
THS3001	1	N	±5, ±15	1	420	385	—	6500	40	−93	−90	−85	0.01	0.02	1.6	3	10	6.6	120	SOIC, MSOP PowerPAD	\$3.05
THS3061/62	1, 2	N	±5, ±15	1	300	275	—	7000	30	−85	−78	−81	0.02	0.01	2.6	3.5	20	8.3	145	SOIC, SOIC PowerPAD	\$2.95
THS3091/5	1	Y	±5, ±15	1	235	210	—	5000	42	−72	−79	−88	0.013	0.02	2	3	15	9.5	280	SOIC, SOIC PowerPAD	\$3.60
THS3092/6	2	Y	±5, ±15	1	235	210	—	5000	42	−72	−79	−88	0.013	0.02	2	4	15	9.5	280	SOIC, SOIC PowerPAD	\$6.00
THS3110/11	1	Y	±5, ±15	1	100	90	—	1300	27	−78	−60	−61	0.01	0.03	3	6	20	4.8	260	SOIC, MSOP PowerPAD	\$1.85
THS3112/15	2	Y	±5, ±15	1	110	110	—	1550	63	−78	−77	−80	0.01	0.011	2.2	8	23	4.9	270	SOIC, SOIC PowerPAD	\$3.05
THS3120/1	1	N	±5, ±15	1	130	—	—	1500	11	−53	−65	−53	0.007	0.018	2.5	2	3	7	475	SOIC, MSOP PowerPAD	\$2.25
THS3122/25	2	Y	±5, ±15	1	160	128	—	1550	64	−78	−70	−77	0.01	0.011	2.2	6	23	8.4	440	SOIC, SOIC PowerPAD	\$3.75
THS3201/02	1, 2	N	±5, ±15	1	1800	850	—	6200	20	−85	−85	−95	0.006	0.03	1.65	0.7	13	14	115	MSOP, SOT23, SOIC	\$1.60

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**.

High-Speed Amplifiers Selection Guide (Continued)

Device	Ch.	SHDN	Supply Voltage (V)	A _{CL} (min)	BW at A _{CL} (MHz) (typ)	BW G = +2 (MHz) (typ)	GBW Product (MHz) (typ)	Slew Rate (V/μs)	Settling Time 0.1% (ns) (typ)	Distortion			Differential		V _N (nV/√Hz) (typ)	V _{OS} (mV) (max)	I _B (μA) (max)	I _Q Per Ch. (mA) (typ)	I _{OUT} (mA) (typ)	Package(s)	Price ¹
										THD 2Vpp G = 1 1MHz (dB) (typ)	1Vpp, G = 2, 5MHz										
											HD2 (dBc) (typ)	HD3 (dBc) (typ)	Gain (%)	Phase (°)							
xDSL Drivers and Receivers																					
OPA2613	2	N	5, ±6	1	230	110	125	70	40	-94	—	—	0.01	0.01	1.8	1	10	6	350	SOIC	\$1.55
OPA2614	2	N	5, ±6	2	180	180	290	145	35	-75	92	110	—	—	1.8	1	14.5	6.5	350	SOP, SOIC	\$1.55
OPA2674	2	Y	5, ±6	1	260	—	—	2000	—	—	-82	-93	0.03	0.01	2	2	10	9	500	SOIC	\$1.80
OPA2677	2	N	5, ±6	1	220	200	—	2000	—	-87	-75	-85	0.03	0.011	2	4.5	30	9	500	SOIC, SOIC PowerPAD™	\$1.75
THS6002	4	N	±5, ±15	1	140	120	—	1000	70	-62	-62	-72	0.05	0.08	—	4	8	4.2	95	SOIC PowerPAD	\$5.30
THS6007	4	N	±5, ±15	1	140	120	—	1300	70	-70	-72	-72	0.05	0.08	1.7	5	9	11.5	500	TSSOP	\$5.50
THS6012	2	N	±5, ±15	1	140	120	—	1300	70	-79	-65	-65	0.05	0.08	1.7	5	9	11.5	500	SOIC PowerPAD, BGA*	\$4.45
THS6022	2	N	±5, ±15	1	210	200	—	1900	70	-75	-55	-58	0.04	0.06	1.7	5	9	7.2	250	TSSOP	\$3.00
THS6032	2	Y	±5, ±15	1	65	60	—	1200	120	-58	-70	-58	0.016	0.4	2.4	5	9	4	440	SOIC PowerPAD, BGA*	\$4.55
THS6042/43	2	Y	±5, ±15	1	120	95	—	1000	—	-75	-40	-60	—	—	2.2	16	12	8.2	350	SOIC, SOIC PowerPAD, TSSOP	\$2.95
THS6052/53	2	Y	±5, ±15	1	120	100	—	850	—	-83	—	—	—	—	2.1	10	10	4.5	175	SOIC, SOIC PowerPAD, TSSOP	\$2.55
THS6062	2	N	5, ±5, ±15	2	100	100	—	100	60	-72	-55	-62	—	—	1.6	6	6	8.5	90	SOIC, MSOP PowerPAD	\$2.35
THS6072	2	N	±5, ±15	1	175	—	—	230	43	-79	-55	-60	—	—	10	7	6	3.4	85	SOIC, MSOP PowerPAD	\$2.35
THS6092/93	2	Y	5, ±6	1	100	—	—	600	—	-72	—	—	—	—	2.1	16	10	6.7	240	SOIC, SOIC PowerPAD	\$2.15
THS6132	2	Y	±5, ±15	1	80	70	—	300	—	-83	-78	-70	—	—	3.5	1	1	6.4	500	QFN TQFP PowerPAD	\$4.05
THS6182	2	Y	±5, ±15	1	100	80	—	450	—	-88	-72	-70	—	—	3.2	20	15	11.5	600	QFN, SOIC PowerPAD	\$3.85
THS6184	4	Y	+4.5 to ±16.5	1	50	—	—	400	—	-83	-83	-61	—	—	2.9	15	15	4.2	500	QFN	\$3.75
Pre-Amp for Tape Pick-Up																					
MPA4609	4	N	5	190	90	—	—	150	—	—	—	—	—	—	0.65	0.2	—	12.5	—	TQFP	\$3.95
Voltage-Limiting Amplifiers																					
OPA698	1	N	5, ±5	1	450	215	250	1100	—	-93	-82	-88	0.012	0.008	5.6	5	10	15.5	120	SOIC	\$1.90
OPA699	1	N	5, ±5	4	260	—	1000	1400	—	—	—	—	0.012	0.008	4.1	5	10	15.5	120	SOIC	\$1.95
RF/IF Amplifiers																					
THS9000/1	1	N	3, 5	5.8	500	—	—	—	—	—	—	—	—	—	0.6	—	—	Var	—	MicroMLP, SOT23	\$1.05
Transimpedance Amplifiers																					
OPAy380	1, 2	N	2.7, 5.0	1	90	45	90	80	2000	—	—	—	—	—	5.8	0.025	50pA	6.5	80	MSOP, SOIC	\$1.95
OPAy381	1, 2	N	2.7, 5.0	1	18	9	18	12	7000 (%0.003)	—	—	—	—	—	10	0.025	50pA	0.8	10	MSOP, DFN	\$1.45
OPA656	1	N	±5	1	400	185	240	290	8	-92	-80	-89	0.01	0.01	6	2	125	25	60	SOIC	\$3.35
OPA657	1	N	±5	7	350	—	1600	700	10	-83	-73	-100	—	—	4.8	1.8	20	14	70	SOT23, SOIC	\$3.80
OPAy846	1, 2	N	±5	7	500	—	1750	625	10	-105	—	—	0.02	0.02	1.2	0.6	19	12.6	80	SOIC, SOT23	\$1.70
OPA847	1	Y	±5, 5	12	600	—	3800	950	10	-110	—	—	—	—	0.85	0.5	39	18.1	75	SOIC, SOT23	\$2.00
THS4631	1	N	+10 to ±15	1	325	105	210	1000	40	-74	-76	-94	—	—	7	0.26	0.05	11.5	98	SOP, MSOP, SOIC	\$5.00

¹Suggested resale price in U.S. dollars in quantities of 1,000. *MicroStar Junior™ BGA

New products are listed in bold red.



Video Amplifiers

Video Amplifiers

Device	Description	Ch.	SHDN	Supply Voltage (V)	-3dB at G = +2 Bandwidth (MHz)	0.1dB Gain Flatness (MHz)	Differential		Slew Rate (μV/s)	Offset Voltage (mV)(max)	I _O Per Ch. (mA) (typ)	Input Voltage Range (V)	RRO	Package(s)	Price ¹
							Gain (%)	Phase (°)							
OPAy690	VFB	1, 2, 3	Y	±5, +5	220	30	0.06	0.03	1800	4	5.5	±3.5	N	SOT23, SOIC	\$1.35
OPAy355	VFB	1, 2, 3	Y	2.5 to 5.5	200	75	0.02	0.05	300	9	8.3	-0.1 to 3	Y	SOT23, SOIC, MSOP, TSSOP	\$0.90
OPAy356	VFB	1, 2	N	2.5 to 5.5	200	75	0.02	0.05	300	9	8.3	-0.1 to 3	Y	SOT23, SOIC, MSOP	\$0.90
OPAy354	VFB	1, 2, 4	N	2.5 to 5.5	100	40	0.02	0.09	150	8	4.9	-0.1 to 5.4	Y	SOT23, SOIC, MSOP, TSSOP	\$0.75
OPAy357	VFB	1, 2	Y	2.5 to 5.5	100	40	0.02	0.09	150	8	4.9	-0.1 to 5.4	Y	SOT23, SOIC, MSOP	\$0.75
OPAy358	VFB	1	Y	2.7 to 3.3	40	12	0.3	0.7	55	6	5.2	-0.1 to 2.3	Y	SC-70	\$0.45
OPA360	VFB, G = 2, SAG Correction, Low-Pass Filter	1	Y	2.7 to 3.3	N/A	5	0.5	1	N/A	N/A	6	1.8	Y	SC-70	\$0.49
OPA361	VFB, G = 5.22, LPF for use with OMAP2420	1	Y	2.7 to 3.3	N/A	5	0.5	1	N/A	N/A	6	0.58	Y	SC-70	\$0.49
OPA656	VFB	1	N	±5	200	30	0.02	0.05	290	1.8	14	-4/+2.5	N	SOT23, SOIC	\$3.35
OPA842	VFB, CCD Video	1	N	±5, +5	150	56	0.003	0.008	400	1.2	20.2	±3.2	N	SOT23, SOIC	\$1.55
SN10501/2/3	VFB	1, 2, 3	N	3 to 15	100	50	0.007	0.007	900	13	14	1.1 to 13.9	Y	SOT23, SOIC, MSOP	\$0.70
OPA695	CFB	1	Y	±5, +5	1400	320	0.04	0.007	4300	3	12.9	±3.3	N	SOT23, SOIC	\$1.35
THS3201	CFB	1	N	±5, +7.5	850	380	0.008	0.007	6200	3	14	±2.5	N	SOT23, SOIC, MSOP	\$1.60
THS3202	CFB	2	N	±5, +7.5	975	380	0.008	0.03	4400	3	14	±2.6	N	SOIC, MSOP	\$2.90
OPAy694	CFB	2	N	±5	690	—	0.03	0.015	1700	4.1	5	±2.5	N	SOIC, SOT23	\$1.25
OPAy691	CFB	1, 2, 3	Y	±5, +5	225	90	0.07	0.02	2100	2.5	5.1	±3.5	N	SOT23, SOIC	\$1.45
OPAy684	CFB	1, 2, 3, 4	Y	±5, +5	160	19	0.04	0.02	820	3.5	1.7	±3.75	N	SOT23, SOIC	\$1.35
OPAy683	CFB	1, 2	Y	±5, +5	150	37	0.06	0.03	540	1.5	0.9	±3.75	N	SOT23, SOIC	\$1.20
OPA693	CFB, G = 2	1	Y	±5, +5	700	200	0.03	0.01	2500	2	13	±3.4	N	SOT23, SOIC	\$1.30
OPAy692	CFB, G = 2	1, 3	Y	±5, +5	240	120	0.07	0.02	2000	2.5	5.1	±3.5	N	SOT23, SOIC	\$1.15
OPAy820	VFB	1, 4	N	±5, ±5	230	—	0.01	0.03	240	0.75	5.6	0.9 to 4.5	N	SO-8, SOT23	\$0.90
OPAy830	VFB	1, 2, 4	N	+2.8, ±5.5	110	—	0.07	0.17	600	7	4.25	-0.45 to 1.2	Y	SO-8, SOT23	\$0.75
OPAy832	VFB, Fixed Gain	1, 2, 3	N	+2.8, ±5	80	—	0.1	0.16	350	7	4.25	-0.5 to 1.5	Y	SO-8, SOT23	\$0.70
THS7303	Low Power	3	Y	2.7, 5.5	N/A	7.7	0.3	0.07	300	25	5	0 to 1.6	Y	TSSOP-20, QFN	\$1.65
THS7313	3-Channel	3	N	2.7, 5	N/A	7.6	0.1	0.1	300	25	7.2	0.01 to 2.45	Y	TSSOP-20, QFN	\$1.55

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in **bold red**. Preview products are listed in **bold blue**.

Comparator ICs are specialized op amps designed to compare two input voltages and provide a logic state output. They can be considered one-bit analog-to-digital converters.

The TI comparator portfolio consists of a variety of products with various performance characteristics, including: fast (ns) response time, wide input voltage ranges, extremely low quiescent current consumption and op amp and comparator combination ICs.

Comparator vs. Op Amp

	Comparator	Op Amp
Speed (Response time)	Yes	No
Logic Output	Yes	No
Wide Diff. Input Range	Yes	Yes
Low Offset Drift	No	Yes

In general, if a fast response time is required, use a comparator.

Design Considerations

Output topology

- Open collector—connects to the logic supply through a pull-up resistor and allows comparators to interface to a variety of logic families.
- Push-pull—does not require a pull-up resistor. Because the output swings rail-to-rail, the logic level is dependent on the voltage supplies of the comparator.

High-Speed Comparator in SOT23

TLV3501

Get samples and datasheets at: www.ti.com/sc/device/TLV3501

Key Features

- High speed: 4.5ns response at 20mV overdrive
- Beyond-the-rail common-mode input range
- Rail-to-rail, push-pull output
- Single-supply operation: 2.7V to 5.5V
- Packaging: SOT23

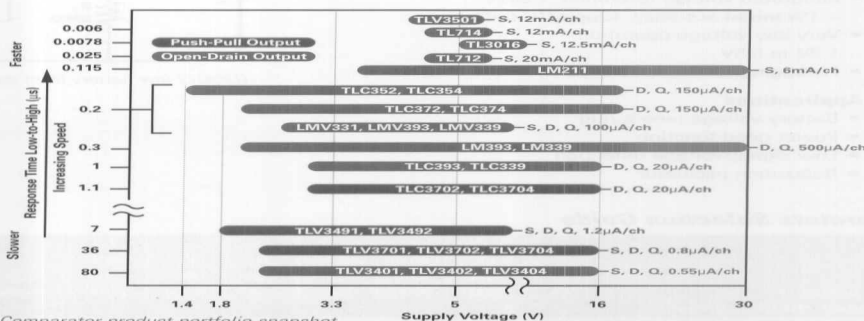
Applications

- Test and measurement
- Power supply monitoring
- Base stations

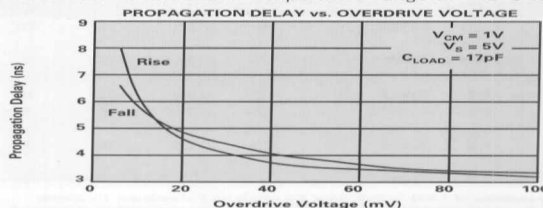
Response time (propagation delay)—applications requiring “near real-time” signal response should consider comparators with nanosecond (ns) propagation delay. Note that as propagation delay decreases, supply current increases. Evaluate what mix of performance and power can be afforded. The TLV349x family offers a unique combination of speed/power with 5μs propagation delay on only 1μA of quiescent current.

Combination comparator and op amp—for input signals requiring DC level shifting and/or gain prior to the comparator, consider the TLV230x (open drain) or TLV270x (push-pull) op amp and comparator combinations. These dual function devices save space and cost.

Comparator and voltage reference—comparators typically require a reference voltage to compare against. The TLV3011 is an integrated comparator and voltage reference combination in a space-saving SC70 package.



The TLV3501 is a high-speed comparator in a small SOT23 package. Designed for a variety of applications, TLV3501 offers very fast response relative to power consumption. It is specified over the extended temperature range of -40°C to $+125^{\circ}\text{C}$.





Comparators

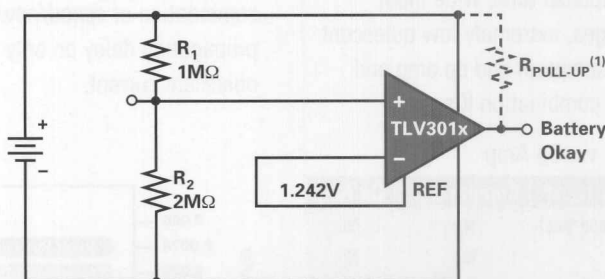
Low-Power Output Comparators with Voltage Reference
TLV3011, TLV3012

Get samples and datasheets at: www.ti.com/sc/device/TLV3011 and www.ti.com/sc/device/TLV3012

Key Features

- Comparator with built-in voltage reference
- TLV3011: open-drain output
- TLV3012: push-pull output
- Low quiescent current: 5µA max
- Wide input common-mode range: 200mV beyond rails
- Propagation delay: 6µs
- Integrated voltage reference: 1.242V
 - 1% initial accuracy, 40ppm/°C drift
- Very low voltage operation: 1.8V to 5.5V
- Packaging: SC70 and SOT23

The TLV3011 is a low-power, open-drain output comparator; the TLV3012 is a push-pull output comparator. The integrated 1.242V series voltage reference offers low 100ppm/°C (max) drift, is stable with up to 10nF capacitive load and can provide up to 0.5mA (typ) of output current.



TLV3012 low battery level detector.

Applications

- Battery voltage monitoring
- Power good function
- Low signal/voltage detection
- Relaxation oscillator

Comparators Selection Guide

Device ²	Description	Ch.	I _Q Per Ch. (mA) (max)	Output Current (mA) (min)	t _{RESP} Low-to-High (µs)	V _S (V) (min)	V _S (V) (max)	V _{OS} (25°C) (mV) (max)	Output Type	Package(s)	Price ¹
High-Speed, t_{RESP} ≤ 0.1µs											
TLV3501	Ultra High Speed, Low Power	1, 2	5	20	0.004	2.7	5.5	5	Push-Pull	SOT23	\$1.50
TL714	High Speed, 10mV (typ) Hysteresis	1	12	16	0.006	4.75	5.25	10	Push-Pull	PDIP, SOIC	\$2.16
TL3016	High Speed, Low Offset	1	12.5	—	0.0078	5	10	3	Open-Drain/Collector	SOIC, TSSOP	\$0.95
TL3116	Ultra Fast, Low Power, Precision	1	14.7	—	0.0099	5	10	3	Open-Drain/Collector	SOIC, TSSOP	\$0.95
TL712	Single, High Speed	1	20	16	0.025	4.75	5.25	5	Push-Pull	PDIP, SOIC, SOP	\$0.83
LM306	Single, Strobed, General Purpose	1	6.8	100	0.028	—6	12	5	Push-Pull	PDIP, SOIC	\$0.63
LM211	Single, High Speed, Strobed	1	6	—	0.115	3.5	30	3	Open-Drain/Collector	PDIP, SOIC	\$0.27
LM311	Single, High Speed, Strobed, Diff.	1	7.5	—	0.115	3.5	30	7.5	Open-Drain/Collector	PDIP, SOIC, SOP, TSSOP	\$0.18
LM111	Single, Strobed, Differential	1	6	—	0.165	3.5	30	3	Open-Drain/Collector	CDIP, LCCC	\$1.37
Low Power, I_Q < 0.5mA											
TLV3401	Nanopower, Open-Drain, RRIO	1, 2, 4	0.00055	—	80	2.5	16	3.6	Open-Drain/Collector	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.60
TLV3701	Nanopower, Push-Pull, RRIO	1, 2, 4	0.0008	—	36	2.5	16	5	Push-Pull	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.60
TLV3491	Low Voltage, Excellent Speed/Power	1, 2	0.0012	—	< 0.1	1.8	5.5	15	Push-Pull	SOT23, SOIC, TSSOP	\$0.42
TLV2302	Sub-µPower, Op Amp and Comparator, RRIO	1, 2	0.0017	—	55	2.5	16	5	Open-Drain/Collector	MSOP, PDIP, SOIC, TSSOP	\$0.90
TLV2702	Sub-µPower, Op Amp and Comparator, RRIO	1, 2	0.0019	—	36	2.5	16	5	Push-Pull	MSOP, PDIP, SOIC, TSSOP	\$0.90
TLC3702	Dual and Quad µPower	2, 4	0.02	4	1.1	3	16	5	Push-Pull	PDIP, SOIC, TSSOP	\$0.34

¹Suggested resale price in U.S. dollars in quantities of 1,000. ²x indicates: 0 = single with shutdown, 1 = single, 2 = dual, 3 = dual with shutdown, 4 = quad, 5 = quad with shutdown. y indicates: no character = single, 2 = dual, 3 = triple, 4 = quad.

New products are listed in **bold red**.

Comparators Selection Guide (Continued)

Device ²	Description	Ch.	I _O Per Ch. (mA) (max)	Output Current (mA) (min)	t _{RESP} Low-to-High (μs)	V _S (V) (min)	V _S (V) (max)	V _{OS} (25°C) (mV) (max)	Output Type	Package(s)	Price ¹
Low Power, I_O < 0.5mA (Continued)											
TLC393	Low Power LM393 Replacement	2	0.02	6	1.1	3	16	5	Open-Drain/Collector	PDIP, SOIC, SOP, TSSOP	\$0.37
TLC339	Quad, Low Power, Open-Drain	4	0.02	6	1	3	16	5	Open-Drain/Collector	PDIP, SOIC, TSSOP	\$0.44
LP2901	Quad, Low Power, General Purpose	4	0.025	—	1.3	5	30	5	Open-Drain/Collector	PDIP, SOIC	\$0.56
LP339	Quad, Low Power, General Purpose	4	0.025	—	1.3	5	30	5	Open-Drain/Collector	PDIP, SOIC	\$0.49
LMV393	Dual, Low Voltage	2	0.1	10	0.2	2.7	5.5	7	Open-Drain/Collector	SOIC, TSSOP	\$0.34
LMV339	Quad, Low Voltage	4	0.1	—	0.2	2.7	5.5	7	Open-Drain/Collector	SOIC, TSSOP	\$0.36
LMV331	Single, Low Voltage	1	0.12	10	0.2	2.7	5.5	7	Open-Drain/Collector	SC70, SOT23	\$0.34
TLC372	Fast, Low Power	2, 4	0.15	6	0.2	2	18	5	Open-Drain/Collector	PDIP, SOIC, TSSOP	\$0.33
TLC3302	Quad, General Purpose	4	0.2	6	0.3	2	28	20	Open-Drain/Collector	PDIP, SOIC	\$0.46
LP211	Single, Strobed, Low Power	1	0.3	—	1.2	3.5	30	7.5	Open-Drain/Collector	SOIC	\$0.50
LP311	Single, Strobed, Low Power	1	0.3	1.6	1.2	3.5	30	7.5	Open-Drain/Collector	PDIP, SOIC, SOP	\$0.46
Low Voltage, V_S ≥ 2.7V (min)											
TLC352	1.4V	2, 4	0.15	6	0.2	1.4	18	5	Open-Drain/Collector	PDIP, SOIC, TSSOP	\$0.40
TLV3491	Low Voltage, Excellent Speed/Power	1, 2, 4	0.0012	—	< 0.1	1.8	5.5	15	Push-Pull	SOT23, SOIC, TSSOP	\$0.42
TLV2352	Low Voltage	2, 4	0.125	6	0.2	2	8	5	Open-Drain/Collector	PDIP, SOIC, TSSOP	\$0.90
TLC372	Fast, Low Power	2	0.15	6	0.2	2	18	5	Open-Drain/Collector	PDIP, SOIC, TSSOP	\$0.33
LM3302	Quad, General Purpose	4	0.2	6	0.3	2	28	20	Open-Drain/Collector	PDIP, SOIC	\$0.46
LM2903	Dual, General Purpose	2	0.5	6	0.3	2	30	7	Open-Drain/Collector	PDIP, SOIC, SOP, TSSOP	\$0.22
LM293	Dual, General Purpose	2	0.5	6	0.3	2	30	5	Open-Drain/Collector	PDIP, SOIC	\$0.28
LM293A	Dual, General Purpose	2	0.5	6	0.3	2	30	3	Open-Drain/Collector	SOIC	\$0.36
LM393	Dual, General Purpose	2	0.5	6	0.3	2	30	5	Open-Drain/Collector	PDIP, SOIC, SOP, TSSOP	\$0.18
LM393A	Dual, General Purpose	2	0.5	6	0.3	2	30	3	Open-Drain/Collector	PDIP, SOIC, SOP, TSSOP	\$0.27
LM239	Quad, General Purpose	4	0.5	6	0.3	2	30	5	Open-Drain/Collector	PDIP, SOIC	\$0.28
LM239A	Quad, General Purpose	4	0.5	6	0.3	2	30	2	Open-Drain/Collector	SOIC	\$0.91
LM2901	Quad, General Purpose	4	0.625	6	0.3	2	30	3	Open-Drain/Collector	PDIP, SOIC, SOP, TSSOP	\$0.22
LM339	Quad, General Purpose	4	0.5	6	0.3	2	30	5	Open-Drain/Collector	PDIP, SOIC, SOP, SSOP, TSSOP	\$0.18
LM339A	Quad, General Purpose	4	0.5	6	0.3	2	30	3	Open-Drain/Collector	PDIP, SOIC, SOP	\$0.27
TL331	Single, Differential	1	0.7	6	0.3	2	36	5	Open-Drain/Collector	SOT23	\$0.28
LM139	Quad	4	0.5	6	0.3	2	36	5	Open-Drain/Collector	SOIC	\$0.54
LM139A	Quad	4	0.5	6	0.3	2	36	2	Open-Drain/Collector	SOIC	\$0.94
LM193	Dual	4	0.5	6	0.3	2	36	5	Open-Drain/Collector	SOIC	\$0.30
TLV3401	Nanopower, Open-Drain, RRIO	1, 2, 4	0.00055	—	80	2.5	16	3.6	Open-Drain/Collector	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.60
TLV3701	Nanopower, Push-Pull, RRIO	1, 2, 4	0.0008	—	36	2.5	16	5	Push-Pull	MSOP, PDIP, SOIC, SOT23, TSSOP	\$0.60
LMV331	Single, Low Voltage	1	0.12	10	0.2	2.7	5.5	7	Open-Drain/Collector	SC70, SOT23	\$0.34
LMV393	Dual, Low Voltage	2	0.1	10	0.2	2.7	5.5	7	Open-Drain/Collector	SOIC, TSSOP	\$0.34
LMV339	Quad Low-Voltage Comparators	4	0.1	—	0.2	2.7	5.5	7	Open-Drain/Collector	SOIC, TSSOP	\$0.36
Combination Comparators and Op Amps											
TLV2302	Sub-μPower, Op Amp and Comparator, RRIO	2	0.0017	—	55	2.5	16	5	Open-Drain/Collector	MSOP, PDIP, SOIC, TSSOP	\$0.90
TLV2702	Sub-μPower, Op Amp and Comparator, RRIO	2, 4	0.0019	—	36	2.5	16	5	Push-Pull	MSOP, PDIP, SOIC, TSSOP	\$0.90
Comparator and Voltage Reference											
TLV3011	μPower Open-Drain Comparator with 1.242V Reference	1	0.003	5	<7	1.8	5.5	15	Open-Drain/Collector	SC-70, SOT23	\$0.75
TLV3012	μPower Push-Pull Comparator with 1.242V Reference	1	0.003	5	<7	1.8	5.5	15	Push-Pull	SC-70, SOT23	\$0.75

¹ Suggested resale price in U.S. dollars in quantities of 1,000. ² x indicates: 0 = single with shutdown, 1 = single, 2 = dual, 3 = dual with shutdown, 4 = quad, 5 = quad with shutdown. y indicates: no character = single, 2 = dual, 3 = triple, 4 = quad.

New products are listed in **bold red**.

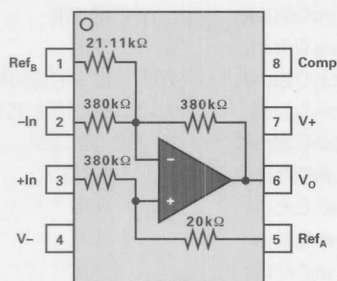


Difference Amplifiers

The difference amplifier is a moderate input impedance, closed-loop, fixed-gain block that allows the acquisition of signals in the presence of ground loops and noise. These devices can be used in a variety of circuit applications—precision, general-purpose, audio, low-power, high-speed and high-common-mode voltage applications.

Difference Amplifier

The basic difference amplifier employs an op amp and four on-chip, precision, laser-trimmed resistors. The INA132, for example, operates on 2.7V to 36V supplies and consumes only 160 μ A. It has a differential gain of 1 and high common-mode rejection. The output signal can be offset by applying a voltage to the Ref pin. The output sense pin can be connected directly at the load to reduce gain error. Because the resistor network divides down the input voltages, difference amplifiers can operate with input signals that exceed the power supplies.



INA132 functional block diagram.

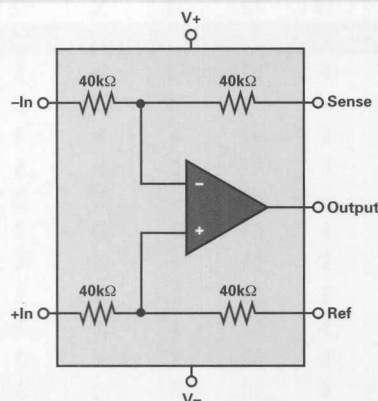
High Common-Mode Voltage Difference Amplifier Topology

A five-resistor version of the simple difference amplifier results in a device that can operate with very high levels of common-mode voltage—far beyond its power supply rails. For example, the INA117 can sense differential signals in the presence of common-mode voltages as high as ± 200 V while being powered from ± 15 V. This device is very useful in measuring current from a high-voltage power supply through a high-side shunt resistor.

Should I Use a Difference Amplifier or Instrumentation Amplifier?

Difference amplifiers excel when measuring signals with common-mode voltages greater than the power supply rails, when there is a low power requirement, when a small package is needed, when the source impedance is low or when a low-cost differential amp is required. The difference amp is a building block of the instrumentation amp.

Instrumentation amplifiers are designed to amplify low-level differential signals where the maximum common-mode voltage is within the supply rails. Generally, using an adjustable gain block, they are well-suited to single-supply applications. The three-op-amp topology works well down to Gain = 1, with a performance advantage in AC CMR. The two-op-amp topology is appropriate for tasks requiring a small package footprint and a gain of 5 or greater. It is the best choice for low-voltage, single-supply applications.



INA117 functional block diagram.

Design Considerations

Power supply—common-mode voltage is always a function of the supply voltage. The INA103 instrumentation amplifier is designed to operate on voltage supplies up to ± 25 V, while the INA122 difference amp can be operated from a 2.2V supply.

Output voltage swing—lower supply voltage often drives the need to maximize dynamic range by swinging close to the rails.

Common-mode input voltage range—selection of the most suitable difference amp begins with an understanding of the input voltage range. Some offer resistor networks that divide down the input voltages, allowing operation with input signals that exceed the power supplies. A five-resistor version of the simple difference amplifier results in a device that can operate with very high levels of

common-mode voltage—far beyond the supply rails.

Gain—signal amplification needed for desired circuit function must be considered. With the uncommitted on-chip op amp, the INA145 and the INA146 can be configured for gains of 0.1 to 1000.

Sensor impedance—should be <0.001 of difference amp impedance to retain CMR and gain accuracy. In other words, the amp input impedance should be 1,000 times higher than the source impedance.

Offset voltage drift (μ V/ $^{\circ}$ C)—input offset voltage changes over temperature. This is more critical in applications with changing ambient temperature.

Quiescent current—often of high importance in battery-powered applications, where amplifier power consumption can greatly influence battery life.

Slew rate—if the signal is reporting a temperature, force or pressure, slew rate is not generally of great concern. If the signal is for an electronic event, (e.g., current, power output) a fast transition is needed.

Common-mode rejection—a measure of unwanted signal rejection and the amp's ability to extract a signal from surrounding DC, power line or other electrical noise.

INA159

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/INA159

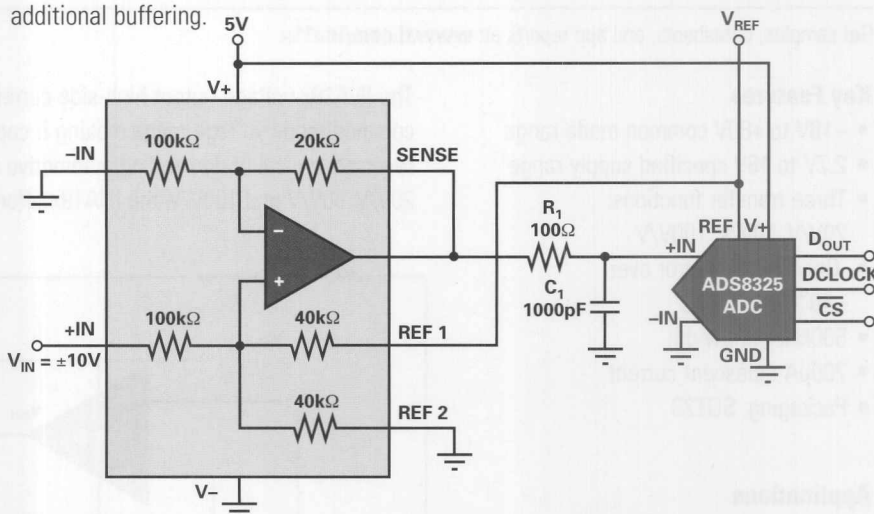
Key Features

- Gain of 0.2 interface between $\pm 10\text{V}$ signals and low-voltage, single-supply ADCs
- Wide bandwidth: 1.5MHz
- Wide slew rate: 8V/ μs
- Low offset voltage: 100 μV
- Low offset drift: $\pm 2\mu\text{V}/^\circ\text{C}$
- Linearity: 0.01% FSR
- Single supply: +2.7V to +5.5V

Applications

- Industrial process control
- Instrumentation
- Differential-to-single-ended conversion
- Audio line receiver

The INA159 is a level translation difference amplifier. It acts as a translator between $\pm 10\text{V}$ levels and the input of single-supply ADCs typically operating at 5V. The INA159 accomplishes this with a gain of 0.2 along with a convenient voltage-divider reference input simplifying the biasing of the INA159's quiescent output to the optimum point for the ADC. The INA159 has a robust output stage, excellent frequency response, and high slew rate—all characteristics necessary for providing a quality ADC drive with no additional buffering.



INA159 functional block diagram.

Difference Amplifiers Selection Guide

Device	Description	Ch.	Gain	Offset (μV) (max)	Offset Drift (μV/°C) (max)	CMRR (dB) (min)	BW (MHz) (typ)	Output Voltage Swing (V) (min)	Power Supply (V)	I _Q Per Ch. (mA) (max)	Package(s)	Price ¹
General Purpose												
INA132	μPower, High Precision	1	1	250	5	76	0.3	(V+) -1 to (V-) +0.5	+2.7 to +36	0.185	DIP, SO	\$1.40
INA2132	Dual INA132	2	1	250	5	76	0.3	(V+) -1 to (V-) +0.5	+2.7 to +36	0.185	DIP, SO	\$2.35
INA133	High Precision, Fast	1	1	450	5	80	1.5	(V+) -1.5 to (V-) +1	±2.25 to ±18	1.2	SOIC-8/-14	\$1.40
INA2133	Dual INA133	2	1	450	5	80	1.5	(V+) -1.5 to (V-) +1	±2.25 to ±18	1.2	SOIC-8/-14	\$2.35
INA143	High Precision, G = 10 or 1/10	1	10, 1/10	250	3	86	0.15	(V+) -1 to (V-) +0.5	±2.25 to ±18	1.2	SOIC-8/-14	\$1.40
INA2143	Dual INA143	2	10, 1/10	250	3	86	0.15	(V+) -1 to (V-) +0.5	±2.25 to ±18	1.2	SOIC-8/-14	\$2.25
INA145	Resistor Programmable Gain	1	1 to 1000	1000	10	76	0.5	(V+) -1 to (V-) +0.5	±1.35 to ±18	0.7	SOIC-8	\$1.50
INA152	μPower, High Precision	1	1	750	5	86	0.7	(V+) -0.2 to (V-) +0.2	+2.7 to +20	0.65	MSOP-8	\$1.20
INA157	High Speed, G = 2 or 1/2	1	2, 1/2	500	20	86	4	(V+) -2 to (V-) +2	±4 to ±18	2.9	SOIC-8	\$1.40
INA159	1.5MHz Precision Level Translation Amp	1	0.2	500	20	86	1.5	(V+) +0.1 to (V-) -0.1	1.8 to 5.5	1.4	MSOP-8	\$1.50
Audio												
INA134	Low Distortion: 0.0005%	1	1	1000	2	74	3.1	(V+) -2 to (V-) +2	±4 to ±18	2.9	SOIC-8/-14	\$1.05
INA2134	Dual INA134	2	1	1000	2	74	3.1	(V+) -2 to (V-) +2	±4 to ±18	2.9	SOIC-8/-14	\$1.70
INA137	Low Distortion, G = 1/2 or 2	1	2, 1/2	1000	2	74	4	(V+) -2 to (V-) +2	±4 to ±18	2.9	SOIC-8/-14	\$1.05
INA2137	Dual INA137	2	2, 1/2	1000	2	74	4	(V+) -2 to (V-) +2	±4 to ±18	2.9	SOIC-8/-14	\$1.70
High-Common-Mode Voltage												
INA117	±200V CM Range	1	1	1000	20	86	0.2	(V+) -5 to (V-) +5	±5 to ±18	2.0	SOIC-8	\$2.70
INA146	±100V CM Range, Prog. Gain	1	0.1 to 100	5000	100	70	0.55	(V+) -1 to (V-) +0.15	±1.35 to ±18	0.7	SOIC-8	\$1.70
INA148	±200V CM Range, 1MΩ Input	1	1	5000	100	70	0.1	(V+) -1 to (V-) +0.25	±1.35 to ±18	0.3	SOIC-8	\$2.10

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Preview products are listed in **bold blue**.



Current Shunt Monitors

Current shunt monitors are used to measure voltage drops across a high- or low-side shunt resistor. These unique difference amplifiers are designed to withstand the presence of high common-mode voltages and provide accurate linear output voltages or currents.

TI offers a variety of voltage and current output current shunt monitors. The INA170 provides bi-directional current sensing on a single chip; useful for battery discharge and charge monitoring. Devices like the INA138 and INA169 can

be used to accurately sense high-side currents up to 38V or 60V common mode voltage. The INA19x common-mode range extends from -16V to $+80\text{V}$ and the INA19x provides a battery voltage output.

-16V to +80V Current Sense Monitor INA19x

Get samples, datasheets, and app reports at: www.ti.com/ina19x

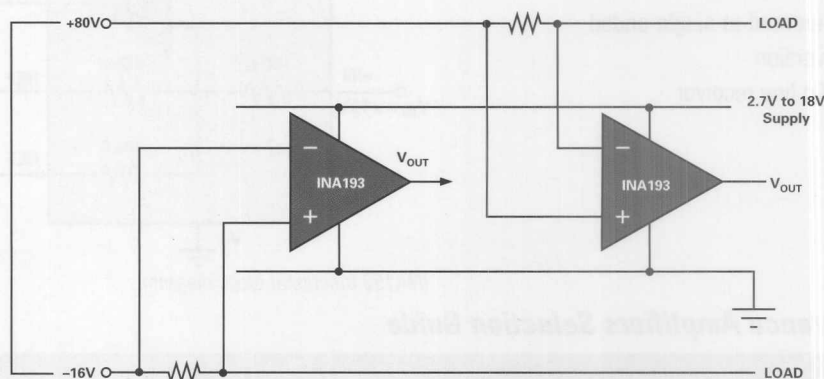
Key Features

- -16V to $+80\text{V}$ common mode range
- 2.7V to 18V specified supply range
- Three transfer functions:
 20V/V , 50V/V , 100V/V
- Only 3% max error over -40°C to $+125^\circ\text{C}$
- 500kHz bandwidth
- $700\mu\text{A}$ quiescent current
- Packaging: SOT23

Applications

- Fault detection
- Power supplies
- Motor control
- Industrial automation
- White goods
- Test and measurement
- Automotive systems
- E-meter: reverse current sense

The INA19x voltage output high-side current shunt monitor features -16V to $+80\text{V}$ of common-mode voltage range making it capable of withstanding shorts and voltage reversals typical of demanding automotive applications. Available in three gain ranges of 20V/V , 50V/V and 100V/V , the INA19x offers flexible performance in a SOT23 package.



INA19x can measure 80V above ground and 16V below ground.

Current Shunt Monitors Selection Guide

Device	Description	Ch.	Gain ($\mu\text{A/V}$)	Offset (μV) (typ)	Offset Drift ($\mu\text{V}/^\circ\text{C}$) (max)	CMRR (dB) (typ)	BW (MHz) (typ)	Output Voltage Swing (V) (min)	Power Supply (V)	I_0 Per Ch. (mA) (max)	Package	Price ¹
Voltage Out High-Side Current Shunt Monitor												
INA19x	-16 to $+80\text{V}$ CMV	1	20, 50, 100	2000	2.5	100	0.4	$V(-)-0.1$ to $(V+)-0.2$	$+2.7$ to 18	0.9	SOT23-5	\$0.80
Current Out High-Side Current Shunt Monitor												
INA138	36V max	1	200	1000	1	100	0.8	0 to $(V+)-0.8$	$+2.7$ to 36	0.045	SOT23-5	\$0.95
INA168	60V max	1	200	1000	1	100	0.8	0 to $(V+)-0.8$	$+2.7$ to 60	0.045	SOT23-5	\$1.15
INA139	High Speed, 40V max	1	1000	1000	1	100	4.4	0 to $(V+)-0.9$	$+2.7$ to 40	0.125	SOT23-5	\$0.95
INA169	High Speed, 60V max	1	1000	1000	1	100	4.4	0 to $(V+)-0.9$	$+2.7$ to 60	0.125	SOT23-5	\$1.21
Bidirectional Current Shunt Monitor												
INA170	60V max	1	1, 100	1000	1	100	0.4	—	$+2.7$ to 40	—	VSSOP-8	\$1.21

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in **bold red**.

Instrumentation Amplifiers

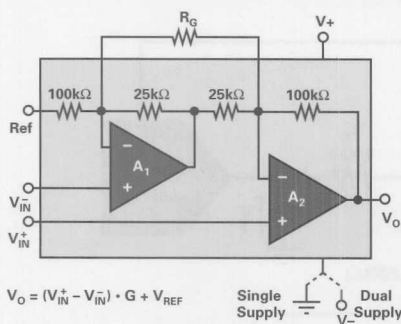
The instrumentation amplifier (IA) is a high input impedance, closed-loop, fixed- or adjustable-gain block that allows for the amplification of low-level signals in the presence of common-mode errors and noise. TI offers many types of instrumentation amplifiers including single-supply, low-power, high-speed and low-noise devices. These instrumentation amplifiers are available in either the traditional three-op-amp or in the cost-effective two-op-amp topology.

Three-Op-Amp Version

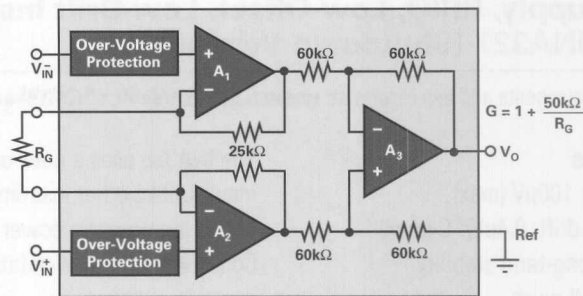
The three-op-amp topology is the benchmark for instrumentation amplifier performance. These devices provide a wide gain range (down to $G = 1$) and generally offer the highest performance. Symmetrical inverting and non-inverting gain paths provide better common-mode rejection at high frequencies. Some types use current-feedback-type input op amps which maintain excellent bandwidth in high gain.

Two-Op-Amp Version

The two-op-amp topology can provide wider common-mode voltage range, especially in low-voltage, single-supply applications. Their simpler internal circuitry allows lower cost, lower quiescent current and smaller package sizes. This topology, however, does not lend itself to gains less than four (INA125) or five (all others).



Two-op-amp topology provides wider common-mode range in low-voltage, single-supply applications.



The three-op-amp topology is the benchmark for instrumentation amplifier performance.

Design Considerations

Supply voltage—TI has developed a series of low-voltage, single-supply, rail-to-rail instrumentation amps suitable for a wide variety of applications requiring maximum dynamic signal range.

Gain requirement—for high-gain applications consider a low total noise device, because drift, input bias current and voltage offset all contribute to error.

Common-mode voltage range—the voltage input range over which the amplifier can operate and the differential pair behaves as a linear amplifier for differential signals.

Input bias current—can be an important factor in many applications, especially those sensing a low current or where the sensor impedance is very high. The INA116 requires only 3fA typical of input bias current.

Offset voltage and drift—IAs are generally used in high-gain applications, where any amp errors are amplified by the circuit gain. This can become a significant portion of the overall signal unless V_{OS} and drift are taken into account. Bipolar amps excel in limiting voltage errors related to offset and drift in low source impedance applications.

Current-feedback vs. voltage-feedback input stage—appropriate for designers needing higher bandwidth or a more consistent 3dB rolloff frequency over various gain settings. The INA128 and INA129 provide a significantly higher 3dB rolloff frequency than voltage-feedback

input stage instrumentation amps and have a 3dB rolloff at essentially the same frequency in both $G = 1$ and $G = 10$ configurations.

Technical Information

IAs output the difference accurately between the input signals providing Common-Mode Rejection (CMR). It is the key parameter and main purpose for using this type of device. CMR measures the device's ability to reject signals that are common to both inputs.

IAs are often used to amplify the differential output of a bridge sensor, amplifying the tiny bridge output signals while rejecting the large common-mode voltage. They provide excellent accuracy and performance, yet require minimal quiescent current. Gain is usually set with a single external resistor.

In some applications unwanted common-mode signals may be less conspicuous. Real-world ground interconnections are not perfect. What may, at first, seem to be a viable single-ended amplifier application can become an accumulation of errors. Error voltages caused by currents flowing in ground loops sum with the desired input signal and are amplified by a single-ended input amp. Even very low impedance grounds can have induced voltages from stray magnetic fields. As accuracy requirements increase, it becomes more difficult to design accurate circuits with a single-ended input amplifier. The differential input instrumentation amplifier is the answer.



Instrumentation Amplifiers

Single-Supply, RRIO, Low-Offset, Low-Drift Instrumentation Amplifier
INA326, INA327 (Shutdown Version)

Get samples, datasheets and app reports at: www.ti.com/sc/device/INA326 and www.ti.com/sc/device/INA327

Key Features

- Low offset: 100 μ V (max)
- Low offset drift: 0.4 μ V/ $^{\circ}$ C (max)
- Excellent long-term stability
- Very-low 1/f noise
- True rail-to-rail I/O
- Input common-mode range:
 - 20mV below negative rail
 - 100mV above positive rail
- Wide output swing: within 10mV of rails
- Supply range: single +2.7V to +5.5V
- Low cost
- INA327: -40° C to $+125^{\circ}$ C
- Packaging: MSOP-8, MSOP-10

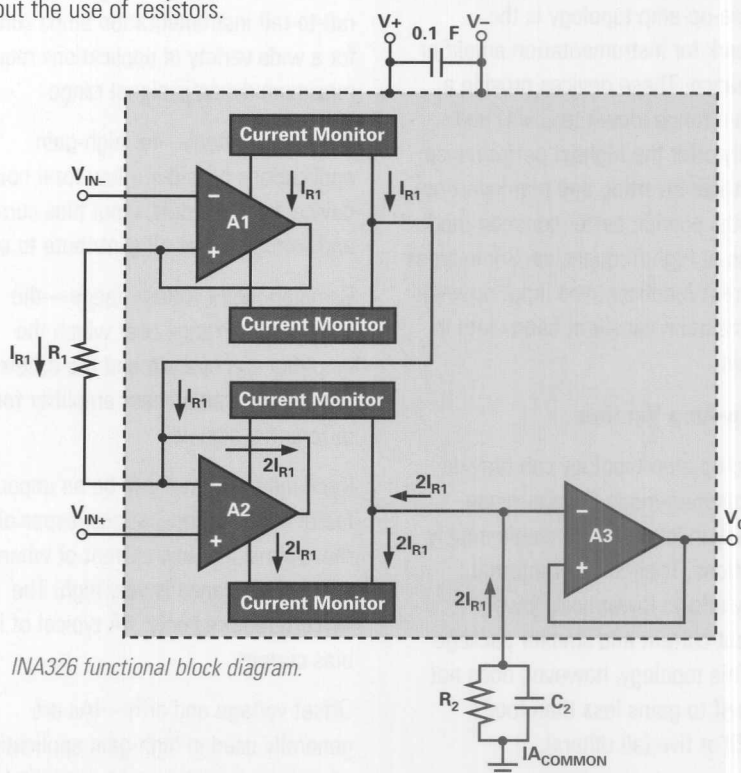
Applications

- Low-level transducer amplifier for bridges, load cells, thermocouples
- Wide dynamic range sensor measurements
- High-resolution test systems
- Weigh scales
- Multi-channel data acquisition system
- Medical instrumentation

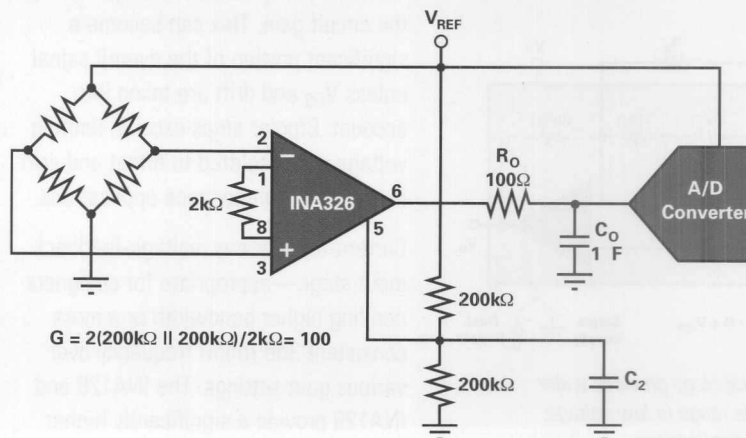
The combination of specifications like CMR of 100dB, gain error of 0.2% (max) and low offset voltage over temperature make the INA326 an optimal candidate for precision instrumentation and measurement in industrial environments. Rail-to-rail output swing allows the INA326 to interface with a single-supply ADC without sacrificing dynamic range.

The INA326 uses a new, unique internal circuit topology that provides true rail-to-rail input. Unlike other instrumentation amplifiers, it can linearly process inputs to 20mV below the negative power supply rail, and 100mV above the positive power supply rail. Conventional instrumentation amplifier input topologies cannot deliver such wide dynamic performance.

In most instrumentation amplifiers, the ability to reject common-mode signals is derived through a combination of input amplifier CMR and accurately matched resistor ratios. The INA326 converts the input voltage to a current, allowing the input amplifiers to accurately match and reject common-mode input voltage and power supply variation without the use of resistors.



INA326 functional block diagram.



The INA326 directly interfaces with single supply A/D converters for precision bridge measurement.

Single-Supply Instrumentation Amplifiers



Single-Supply Instrumentation Amplifiers Selection Guide

Device	Description	Gain	Non Linearity (%) (max)	Input Bias Current (nA) (max)	Offset at G = 100 (μV) (max)	Offset Drift (μV/°C) (max)	CMRR at G = 100 (dB) (min)	BW at G = 100 (kHz) (min)	Noise 1kHz (nV/√Hz) (typ)	Power Supply (V)	I _Q Per Amp (mA) (max)	Package(s)	Price ¹
Single-Supply, Low Power, I_Q < 525μA per Instrumentation Amp													
INA321	RRO, SHDN, Low Offset, Gain Error, Wide Temp	5 to 10000	0.01	0.01	1000	7 ²	90	50	100	2.7 to 5.5	0.06	MSOP-8	\$1.45
INA2321	Dual INA321	5 to 10000	0.01	0.01	1000	7 ²	90	50	100	2.7 to 5.5	0.06	TSSOP-14	\$1.75
INA322	RRO, SHDN, Wide Temp, Low Cost	5 to 10000	0.01	0.01	10000	7	60	50	100	2.7 to 5.5	0.06	MSOP-8	\$0.95
INA2322	Dual INA322	5 to 10000	0.01	0.01	10000	7	60	50	100	2.7 to 5.5	0.06	TSSOP-14	\$1.50
INA122	μPower, RRO, CM to GND	5 to 10000	0.012	25	250	3	90	5	60	2.2 to 36	0.085	DIP-8, SOIC-8	\$2.58
INA332	RRO, Wide BW, SHDN, Wide Temp, Low Cost	5 to 1000	0.01	0.01	10000	7 ²	60	500	100	2.7 to 5.5	0.1	MSOP-8	\$1.05
INA2332	Dual INA332	5 to 1000	0.01	0.01	10000	7 ²	60	500	100	2.7 to 5.5	0.1	MSOP-8	\$1.35
INA126	μPower, < 1V V _{SAT} , Low Cost	5 to 10000	0.012	25	250	3	83	9	35	2.7 to 36	0.2	DIP/SO/MSOP-8	\$1.31
INA2126	Dual INA126	5 to 10000	0.012	25	250	3	83	9	35	2.7 to 36	0.2	DIP/SO/MSOP-16	\$2.35
INA118	Precision, Low Drift, Low Power ³	1 to 10000	0.002	5	55	0.7	107	70	10	2.7 to 36	0.385	DIP-8, SOIC-8	\$4.15
INA331	RRO, Wide BW, SHDN, Wide Temp	5 to 1000	0.01	0.01	500	5 ²	90	2000	46	2.7 to 5.5	0.5	MSOP-8	\$1.40
INA2331	Dual INA331	5 to 1000	0.01	0.01	1000	5 ²	80	2000	46	2.7 to 5.5	0.5	TSSOP-14	\$1.80
INA125	Internal Ref, Sleep Mode ³	4 to 10000	0.01	25	250	2	100	4.5	38	2.7 to 36	0.525	DIP-8, SOIC-16	\$2.55
Single-Supply, Low Input Bias Current, I_B < 50pA													
INA155	Low Offset, RRO, Wide Temp, SR = 6.5V/μs	10, 50	0.015	0.01	1000	5 ²	86	110	40	2.7 to 5.5	2.1	MSOP-8	\$1.45
INA156	Low Offset, RRO, Low Cost, Wide Temp, SR = 6.5V/μs	10, 50	0.015	0.01	8000	5 ²	86	110	40	2.7 to 5.5	2.1	SOIC-8, MSOP-8	\$0.95
INA321	RRO, SHDN, Low Offset, Gain Error, Wide Temp	5 to 10000	0.01	0.01	1000	7 ²	90	50	100	2.7 to 5.5	0.06	MSOP-8	\$1.45
INA2321	Dual INA321	5 to 10000	0.01	0.01	1000	7 ²	90	50	100	2.7 to 5.5	0.06	TSSOP-14	\$1.75
INA322	RRO, SHDN, Wide Temp, Low Cost	5 to 10000	0.01	0.01	10000	7	60	50	100	2.7 to 5.5	0.06	MSOP-8	\$0.95
INA2322	Dual INA322	5 to 10000	0.01	0.01	10000	7	60	50	100	2.7 to 5.5	0.06	TSSOP-14	\$1.50
INA331	RRO, Wide BW, SHDN, Wide Temp	5 to 1000	0.01	0.01	500	5 ²	90	2000	46	2.7 to 5.5	0.5	MSOP-8	\$1.40
INA2331	Dual INA331	5 to 1000	0.01	0.01	1000	5 ²	80	2000	46	2.7 to 5.5	0.5	TSSOP-14	\$1.80
INA332	RRO, Wide BW, SHDN, Wide Temp, Low Cost	5 to 1000	0.01	0.01	10000	7 ²	60	500	100	2.7 to 5.5	0.1	MSOP-8	\$1.05
INA2332	Dual INA332	5 to 1000	0.01	0.01	10000	7 ²	60	500	100	2.7 to 5.5	0.1	TSSOP-14	\$1.35
Single-Supply, Precision, V_{OS} < 300μV, Low V_{OS} Drift													
INA118	Precision, Low Drift, Low Power ³	1 to 10000	0.002	5	55	0.7	107	70	10	2.7 to 36	0.385	DIP-8, SOIC-8	\$4.15
INA326	RRIO, Auto-Zero, CM > Supply, Low Drift	0.1 to 10000	0.01	2	100	0.4	100	1	33	2.7 to 5.5	3.4	MSOP-8	\$1.80
INA327	RRIO, Auto-Zero, SHDN, CM > Supply, Low Drift	0.1 to 10000	0.01	2	100	0.4	100	1	33	2.7 to 5.5	3.4	MSOP-10	\$1.95
INA337	RRIO, Auto-Zero, Low Drift, CM > Supply, Wide Temp	0.1 to 10000	0.01	2	100	0.4	106	1	33	2.7 to 5.5	3.4	MSOP-8	\$1.80
INA338	RRIO, Auto-Zero, Low Drift, CM > Supply, SHDN, Wide Temp	0.1 to 10000	0.01	2	100	0.4	106	1	33	2.7 to 5.5	3.4	MSOP-10	\$1.95
INA122	μPower, RRO, CM to GND	5 to 10000	0.012	25	250	3	90	5	60	2.2 to 36	0.085	DIP-8, SOIC-8	\$2.58
INA125	Internal Ref, Sleep Mode ³	4 to 10000	0.01	25	250	2	100	4.5	38	2.7 to 36	0.525	DIP-8, SOIC-16	\$2.55
INA126	μPower, < 1V V _{SAT} , Low Cost	5 to 10000	0.012	25	250	3	83	9	35	2.7 to 36	0.2	DIP/SO/MSOP-8	\$1.31
INA2126	Dual INA126	5 to 10000	0.012	25	250	3	83	9	35	2.7 to 36	0.2	DIP/SO/MSOP-16	\$2.35
Signal Amplifiers for Temperature Control													
INA330	Optimized for Precision 10k Thermistor Applications	—	—	0.23	—	0.009°C ²	—	1	0.0001°C pp ²	2.7 to 5.5	3.6	MSOP-10	\$1.55

¹Suggested resale price in U.S. dollars in quantities of 1,000.²Typical.³Internal +40V input protection.⁴–40°C to +85°C.New products are listed in **bold red**.



Dual-Supply Instrumentation Amplifiers

Dual-Supply Instrumentation Amplifiers Selection Guide

Device	Description	Gain	Non Linearity (%) (max)	Input Bias Current (nA) (max)	Offset at $G = 100$ (μ V) (max)	Offset Drift (μ V/ $^{\circ}$ C) (max)	CMRR at $G = 100$ (dB) (min)	BW at $G = 100$ (kHz) (min)	Noise 1kHz (nV/ $\sqrt{\text{Hz}}$) (typ)	Power Supply (V)	I_Q Per Amp (mA) (max)	Package(s)	Price ¹
Dual-Supply, Low Power $I_Q < 850\mu\text{A}$ per Instrumentation Amp													
INA122	μ Power, RRO, CM to GND	5 to 10000	0.012	25	250	3	90	5	60	± 1.3 to ± 18	0.085	DIP-8, SOIC-8	\$2.58
INA126 ⁴	μ Power, $< 1\text{V } V_{\text{SAT}}$, Low Cost	5 to 10000	0.012	25	250	3	83	9	35	± 1.35 to ± 18	0.2	DIP/SO/MSOP-8	\$1.31
INA118	Precision, Low Drift, Low Power ²	1 to 10000	0.002	5	55	0.7	107	70	10	± 1.35 to ± 18	0.385	DIP-8, SOIC-8	\$4.15
INA121	Low Bias, Precision, Low Power ²	1 to 10000	0.005	0.05	500	5	100	50	20	± 2.25 to ± 18	0.525	DIP-8, SO-8	\$3.55
INA125	Internal Ref, Sleep Mode ²	4 to 10000	0.01	25	250	2	100	4.5	38	± 1.35 to ± 18	0.525	DIP-8, SOIC-16	\$2.55
INA128 ⁴	Precision, Low Noise, Low Drift ²	1 to 10000	0.002	5	60	0.7	120	200	8	± 2.25 to ± 18	0.8	DIP-8, SOIC-8	\$4.27
INA129	Precision, Low Noise, Low Drift, AD620 Second Source ²	1 to 10000	0.002	5	60	0.7	120	200	8	± 2.25 to ± 18	0.8	DIP-8, SOIC-8	\$4.95
INA141 ⁴	Precision, Low Noise, Low Power, Pin Compatible with AD6212 ²	10, 100	0.002	5	50	0.7	110	200	8	± 2.25 to ± 18	0.8	DIP-8, SOIC-8	\$5.70
Dual-Supply, Low Input Bias Current $I_B < 50\text{pA}$													
INA110	Fast Settle, Low Noise, Wide BW	1, 10, 100, 200, 500	0.01	0.05	280	2.5	106	470	10	± 6 to ± 18	4.5	DIP-16, SOIC-16	\$7.00
INA121	Precision, Low Power ²	1 to 10000	0.005	0.05	500	5	100	50	20	± 2.25 to ± 18	0.525	DIP-8, SO-8	\$3.55
INA111	Fast Settle, Low Noise, Wide BW	1 to 10000	0.005	0.02	520	6	106	450	10	± 6 to ± 18	4.5	DIP-8, SO-16	\$4.20
INA116	Ultra Low I_B 3fA (typ), with Buffered Guard Drive Pins ²	1 to 10000	0.01	0.0001	5000	40	80	70	28	± 4.5 to ± 18	1.4	DIP-16, SO-16	\$4.20
Dual-Supply, Precision $V_{OS} < 300\mu\text{V}$, Low V_{OS} Drift													
INA114	Precision, Low Drift ²	1 to 10000	0.002	2	50	0.25	110	10	11	± 2.25 to ± 18	3	DIP-8, SO-16	\$4.20
INA115	Precision, Low Drift, w/Gain Sense Pins ²	1 to 10000	0.002	2	50	0.25	120	10	11	± 2.25 to ± 18	3	SO-16	\$4.20
INA131	Low Noise, Low Drift ²	100	0.002	2	50	0.25	110	70	12	± 2.25 to ± 18	3	DIP-8	\$5.70
INA141 ⁴	Precision, Low Noise, Low Power, Pin Compatible with AD6212 ²	10, 100	0.002	5	50	0.7	110	200	8	± 2.25 to ± 18	0.8	DIP-8, SOIC-8	\$5.70
INA118	Precision, Low Drift, Low Power ²	1 to 10000	0.002	5	55	0.7	107	70	10	± 1.35 to ± 18	0.385	DIP-8, SOIC-8	\$4.15
INA128 ⁴	Precision, Low Noise, Low Drift ²	1 to 10000	0.002	5	60	0.7	120	200	8	± 2.25 to ± 18	0.8	DIP-8, SOIC-8	\$4.27
INA129	Precision, Low Noise, Low Drift, AD620 Second Source ²	1 to 10000	0.002	5	60	0.7	120	200	8	± 2.25 to ± 18	0.8	DIP-8, SOIC-8	\$4.95
INA122	μ Power, RRO, CM to GND	5 to 10000	0.012	25	250	3	90	5	60	± 1.3 to ± 18	0.085	DIP-8, SOIC-8	\$2.58
INA125	Internal Ref, Sleep Mode ²	4 to 10000	0.01	25	250	2	100	4.5	38	± 1.35 to ± 18	0.525	DIP-8, SOIC-16	\$2.55
INA126 ⁴	μ Power, $< 1\text{V } V_{\text{SAT}}$, Low Cost	5 to 10000	0.012	25	250	3	83	9	35	± 1.35 to ± 18	0.2	DIP/SO/MSOP-8	\$1.31
INA101	Low Noise, Wide BW, Gain Sense Pins, Wide Temp	1 to 10000	0.007	30	259	23	100	25	13	± 5 to ± 18	8.5	PDIP-14, SO-16	\$7.95
INA110	Fast Settle, Low Noise, Low Bias, Wide BW	1, 10, 100, 200, 500	0.01	0.05	280	2.5	106	470	10	± 6 to ± 18	4.5	CDIP-16	\$7.00
Dual-Supply, Lowest Noise													
INA103	Precision, Fast Settle, Low Drift, Audio, Mic Pre Amp, THD+N = 0.0009%	1, 100	0.0006 ³	12000	255	1.2 ³	100	800	1	± 9 to ± 25	13	DIP-16, SO-16	\$5.00
INA163	Precision, Fast Settle, Low Drift, Audio, Mic Pre Amp, THD+N = 0.002%	1 to 10000	0.0006 ³	12000	300	1.2 ³	100	800	1	± 4.5 to ± 18	12	SOIC-14	\$2.50
INA166	Precision, Fast Settle, Low Drift, Audio, Mic Pre Amp, THD+N = 0.09%	2000	0.005	12000	300	2.5 ³	100	450	1.3	± 4.5 to ± 18	12	SO-14 Narrow	\$5.95
INA217	Precision, Low Drift, Audio, Mic Pre Amp, THD+N = 0.09% SSM2017 Replacement	1 to 10000	0.0006 ³	12000	300	1.2 ³	100	800	1.3	± 4.5 to ± 18	12	DIP-8, SO-16	\$2.50

¹Suggested resale price in U.S. dollars in quantities of 1,000.²Internal +40V input protection.³Typical.⁴Parts also available in dual version.

Digitally Programmable Gain Amplifiers

Programmable gain instrumentation amplifiers (PGAs) are extremely versatile data acquisition input amplifiers that provide digital control of gain for improved accuracy and extended dynamic range. Many have inputs that are protected to $\pm 40\text{V}$ even with the power supply off. A single input amplifier type can be connected to a variety of sensors or signals. Under processor control, the switched gain extends the dynamic range of the system.

All PGA-series amps have TTL- or CMOS-compatible inputs for easy microprocessor interface. Inputs are laser trimmed for low offset voltage and low drift to allow use without the need of external components.

Design Considerations

Primary

Digitally-selected gain required—two pins allow the selection of up to four different gain states. A PGA202 and PGA203 can be put in series for greater gain selection.

Non-linearity (accuracy)—depends heavily on what is being driven. A 16-bit converter will require significantly better accuracy (i.e., lower non-linearity) than a 10-bit converter.

Secondary

Gain error and drift—for higher gain, high-precision applications will require closer attention to drift and gain error.

Input bias current—High source impedance applications often require FET-input amps to minimize bias current errors.

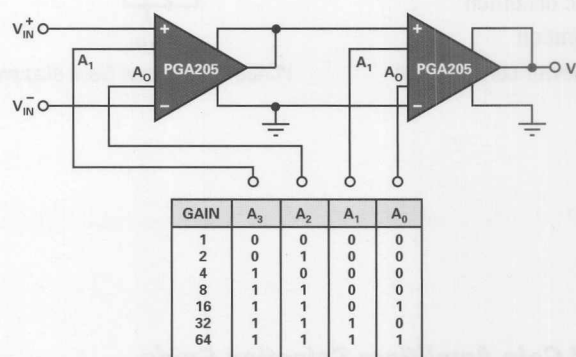
Technical Information

The PGA206 provides binary gain steps of 1, 2, 4 and 8V/V, selected by CMOS- or TTL-compatible inputs. The PGA207 has gains of 1, 2, 5 and 10V/V, adding a full decade to the system dynamic range. The low input bias current, FET-input stage assures that series resistance of the multiplexer does not introduce errors. Fast settling time ($3.5\mu\text{s}$ to 0.01%) allows fast polling of many channels.

The PGA204 and PGA205 have precision bipolar input stages especially well suited to low-level signals. The PGA205 has gain steps of 1, 2, 4 and 8.

Typical Applications

- Data acquisition
- Auto-ranging circuits
- Remote instrumentation
- Test equipment
- Medical/physiological instrumentation
- General analog interface boards



Connecting two programmable gain amps can provide binary gain steps $G = 1$ to $G = 64$.

Digitally Programmable Gain Amplifiers Selection Guide

Device	Description	Gain	Non Linearity at $G = 100$ (%) (max)	Offset (μV) (max)	Offset Drift ($\mu\text{V}/^\circ\text{C}$) (max)	CMRR at $G = 100$ (dB) (min)	BW at $G = 100$ (kHz) (typ)	Noise at 1kHz ($\text{nV}/\sqrt{\text{Hz}}$) (typ)	Power Supply (V)	I_Q (mA) (max)	Package(s)	Price ¹
PGA103	Precision, Single-Ended Input	1, 10, 100	0.01	500	2 (typ)	—	250	11	± 4.5 to ± 18	3.5	SOIC-8	\$4.35
PGA202	High Speed, FET-Input, 50pA I_B	1, 10, 100, 1000	0.012	1000	12	92	1000	12	± 4.5 to ± 18	6.5	DIP-14	\$7.75
PGA203	High Speed, FET-Input, 50pA I_B	1, 2, 4, 8	0.012	1000	12	92	1000	12	± 4.5 to ± 18	6.5	DIP-14	\$7.75
PGA204	High Precision, Gain Error: 0.25% ²	1, 10, 100, 1000	0.002	50	0.25	110	10	13	± 4.5 to ± 18	5.2	SOIC-16	\$7.25
PGA205	Gain Drift: 0.024ppm/ $^\circ\text{C}^2$	1, 2, 4, 8	0.002	50	0.25	95	100	15	± 4.5 to ± 18	5.2	SOIC-16	\$7.25
PGA206	High Speed, FET-Input ² , 100pA I_B	1, 2, 4, 8	0.002	1500	2 (typ)	95	600	18	± 4.5 to ± 18	12.4	DIP-16, SOIC-16	\$10.80
PGA207	High Speed, FET-Input ² , 100pA I_B	1, 2, 5, 10	0.002	1500	2 (typ)	95	600	18	± 4.5 to ± 18	12.4	DIP-16, SOIC-16	\$11.85
PGA309	Complete Digitally Calibrated Bridge Sensor Conditioner, Voltage Output	8 to 1152	Digitally Calibrated ³	—	—	—	20	—	+2.7 to +5.5	—	TSSOP-16	\$3.40

¹Suggested resale price in U.S. dollars in quantities of 1,000. ²Internal $\pm 40\text{V}$ input protection. ³See "Sensor Conditioners and 4-20mA Transmitters" section for details, pages 42-43.



Voltage-Controlled Gain Amplifiers

The voltage-controlled gain amplifier (VCA) provides linear dB gain and gain-range control with high impedance inputs. Available in single, dual and octal configurations, the VCA series is designed to be used as a flexible gain-control element in a variety of electronic systems. With a broad gain-control range, both gain and attenuation control are provided for maximum flexibility.

Design Considerations

Primary

- Input frequency
- Noise (nV/√Hz)
- Variable gain range

Secondary

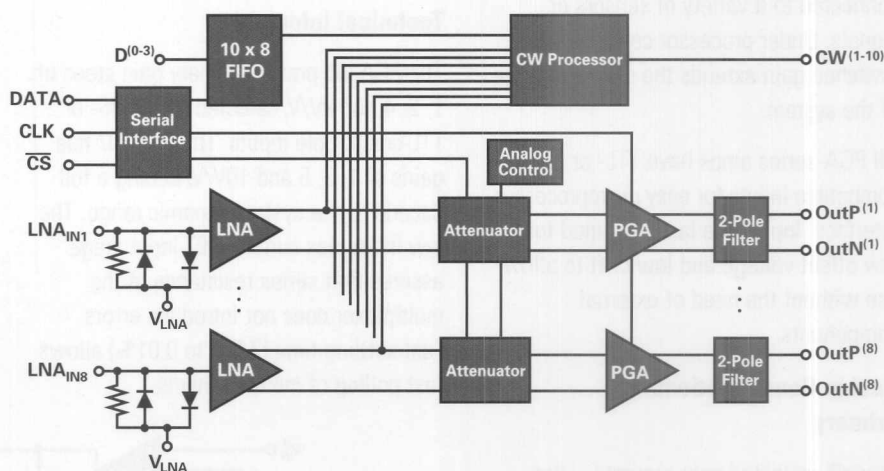
- Number of channels
- Distortion—low second harmonic and third harmonic distortion
- Level of integration
- Per channel power consumption

Technical Information

The broad attenuation range can be used for gradual or controlled channel turn-on or turn-off where abrupt gain changes can create artifacts and other errors.

Typical Applications

- Ultrasound systems
- Wireless receivers
- Test equipment



VCA8617 functional block diagram.

Voltage-Controlled Gain Amplifiers Selection Guide

Device	V_N (nV/√Hz)	Bandwidth (MHz) (typ)	Specified at V_S (V)	Number of Channels	Variable Gain Range (dB)	Package	Price ¹
VCA2612	1.25	40	5	2	45	TQFP-48	\$12.50
VCA2613	1	40	5	2	45	TQFP-48	\$10.25
VCA2614	4.8	40	5	2	40	TQFP-32	\$8.35
VCA2616/2611	1	40	5	2	45	TQFP-48	\$10.25
VCA810	2.4	30	±5V	1	80	SO-8	\$5.75
VCA2618	5.5	40	5	2	45	TQFP-32	\$8.40
THS7530	1.27	300	5	1	46	HTSSOP-14 PowerPAD™	\$3.65
VCA8613	1.2	14	3	8	40	TQFP-64	\$25.40
VCA2619	5.9	40	5	2	50	TQFP-32	\$8.40
VCA2615	0.7	50	5	2	44	QFN-48	\$10.25
VCA2617	3.8	50	5	2	48	QFN-32	\$8.40
VCA8617	1	15	3	8	40	TQFP-64	\$24.00

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in **bold red**. Preview products are listed in **bold blue**.

Voltage-Controlled Gain Amplifiers



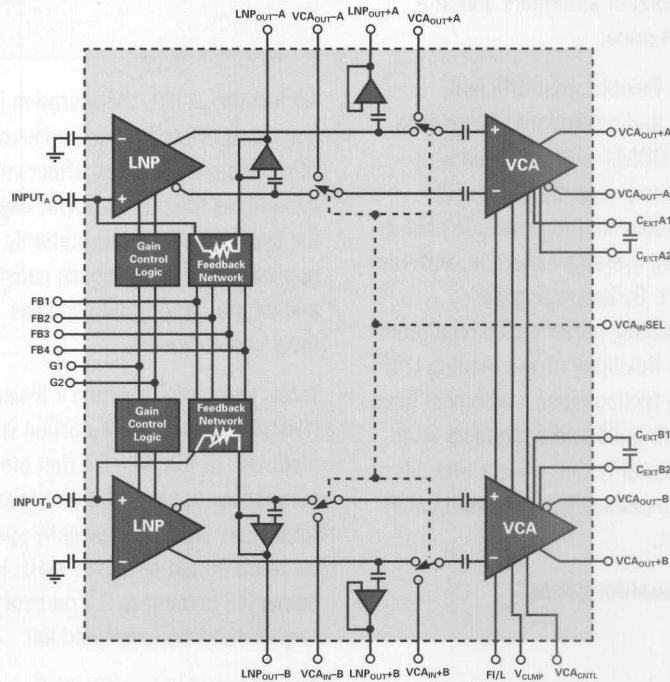
Two-Channel Variable Gain Amplifier VCA2615

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/VCA2615

Key Features

- 5V operation
- Ultra-low noise LNA: $0.7\text{nV}/\sqrt{\text{Hz}}$
- Low-power CMOS technology
- 52dB gain range
- 6dB VGA gain adjustment
- Configurable active termination resistance
- Buffered LNP outputs
- 50MHz LNP bandwidth
- 150mW/channel
- Pin similar to VCA2616

The VCA2615 is a two-channel variable gain amplifier well suited to high-end ultrasound applications. Excellent dynamic performance enables use in low-power, high-performance applications. Each channel consists of a programmable Low Noise Preamplifier (LNP) and a Variable Gain Amplifier (VGA).



VCA2615 functional block diagram.

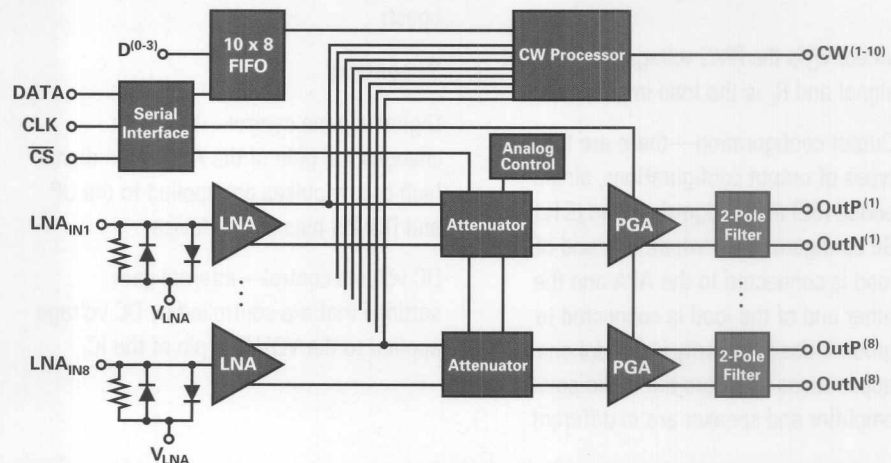
8-Channel Variable Gain Amplifier VCA8617

Get samples, datasheets, EMVs and app reports at: www.ti.com/sc/device/VCA8617

Key Features

- 3V operation
- Low input noise: $1.0\text{nV}/\sqrt{\text{Hz}}$ at $f_{\text{IN}} = 5\text{MHz}$
- Extremely low power operation: 100mW/channel
- Integrated low-pass, 2-pole filter 15MHz bandwidth
- Integrated input clamp diodes
- Differential output
- Integrated input LNA
- Readable control registers
- Integrated continuous wave (CW) switch matrix

The VCA8617 is an 8-channel LNA and VGA with integrated CW switch matrix circuitry and low-pass filtering. This high level of integration reduces cost and lessens the need for external circuitry.



The VCA8617 is an 8-channel variable gain amplifier well suited for portable ultrasound applications.



Audio Amplifiers

Consumers are enjoying new ways to listen to music, books and news, while demanding more flexibility, better quality and multifunctional products. There is an ever-increasing demand for high-end entertainment for the everyday consumer. The market expects the best listening experience from any audio format and source, mobile or stationary and at a competitive price.

By offering flexible, cost-efficient, end-to-end audio solutions, TI provides OEMs and ODMs with faster time-to-market and one-stop shopping. TI's complete audio solutions include best-in-class silicon, systems expertise, software and support. By leveraging the programmability, performance headroom and design flexibility of TI's leading DSP and analog technologies, customers have the ability to build audio products with more functionality that offer a true, life-like sound experience at a lower overall system cost.

Design Considerations

Primary

Output power—supply voltage and load impedance limit the level of output power (i.e., volume) an audio power amp (APA) can drive. Always verify that the desired output power is theoretically possible with the equation:

$$P_O = \frac{V_O^2}{R_L}$$

where V_O is the RMS voltage of the output signal and R_L is the load impedance.

Output configuration—there are two types of output configurations, single-ended (SE) and bridge-tied load (BTL). An SE configuration is where one end of the load is connected to the APA and the other end of the load is connected to ground. Used primarily in headphone applications or where the audio power amplifier and speaker are in different

enclosures. A BTL configuration is where both ends of the load are connected to an APA. This configuration effectively quadruples the output power capability of the system and is used primarily in applications that are space constrained and where the APA and speaker are in the same enclosure.

Total Harmonic Distortion + Noise (THD+N)—harmonic distortion is distortion at frequencies that are whole number multiples of the test tone frequency. THD+N is typically specified for rated output power at 1kHz. Values below 0.5 percent to 0.3 percent are negligible to the untrained ear.

Amplifier technology (Class-D and Class-AB)—Class-D and Class-AB are the most common APAs in consumer electronics, because of their great performance and low cost. Class-D amps are very efficient and provide the longest battery life and lowest heat dissipation. Class-AB amps offer the greatest selection of features (e.g., digital volume control and bass boost).

Secondary

Digital volume control—this input changes the gain of the APA when digital high or low pulses are applied to the UP and DOWN pins of the device.

DC volume control—internal gain settings that are controlled by DC voltage applied to the VOLUME pin of the IC.

TI's New Audio Quick Search Tools!

On TI's Audio Home Page, we have added a great new feature! Our Audio Quick Search Tool allows you to easily find the Audio device based on your design specifications. It's easy to use, just go to www.ti.com/audio and select one of the available tools, such as Audio Amplifiers, Converters or CODECs. Select your options and the suggested device will take you directly to the product folder.

www.ti.com/audio

Integrated gain settings—the internal gain settings are controlled via the input pins, $GAIN_0$ and $GAIN_1$, of the IC.

DEPOP—circuitry internal to the APA. It minimizes voltage spikes when the APA turns on, off, or transitions in or out of shutdown mode.

MUX—allows two different audio sources to the APA that are controlled independently of the amplifier configuration.

Shutdown—circuitry that places the APA in a very low power consumption standby state.

Technical Information

TI APAs are easy to design with, requiring only a few external components.

Power supply capacitors— CV_{DD} minimizes THD by filtering off the low frequency noise and the high frequency transients.

Input capacitors—in the typical application, C_{IN} is required to allow the amplifier to bias the input signal to the proper dc level for optimum operation. C_{IN} is usually in the 0.1μF to 10μF range for good low-frequency response.

Bypass capacitor— C_{BYPASS} controls the start up time and helps to reduce the THD. Typically, this capacitor is ten times larger than the input decoupling capacitors (C_{IN}).

Audio Amplifiers

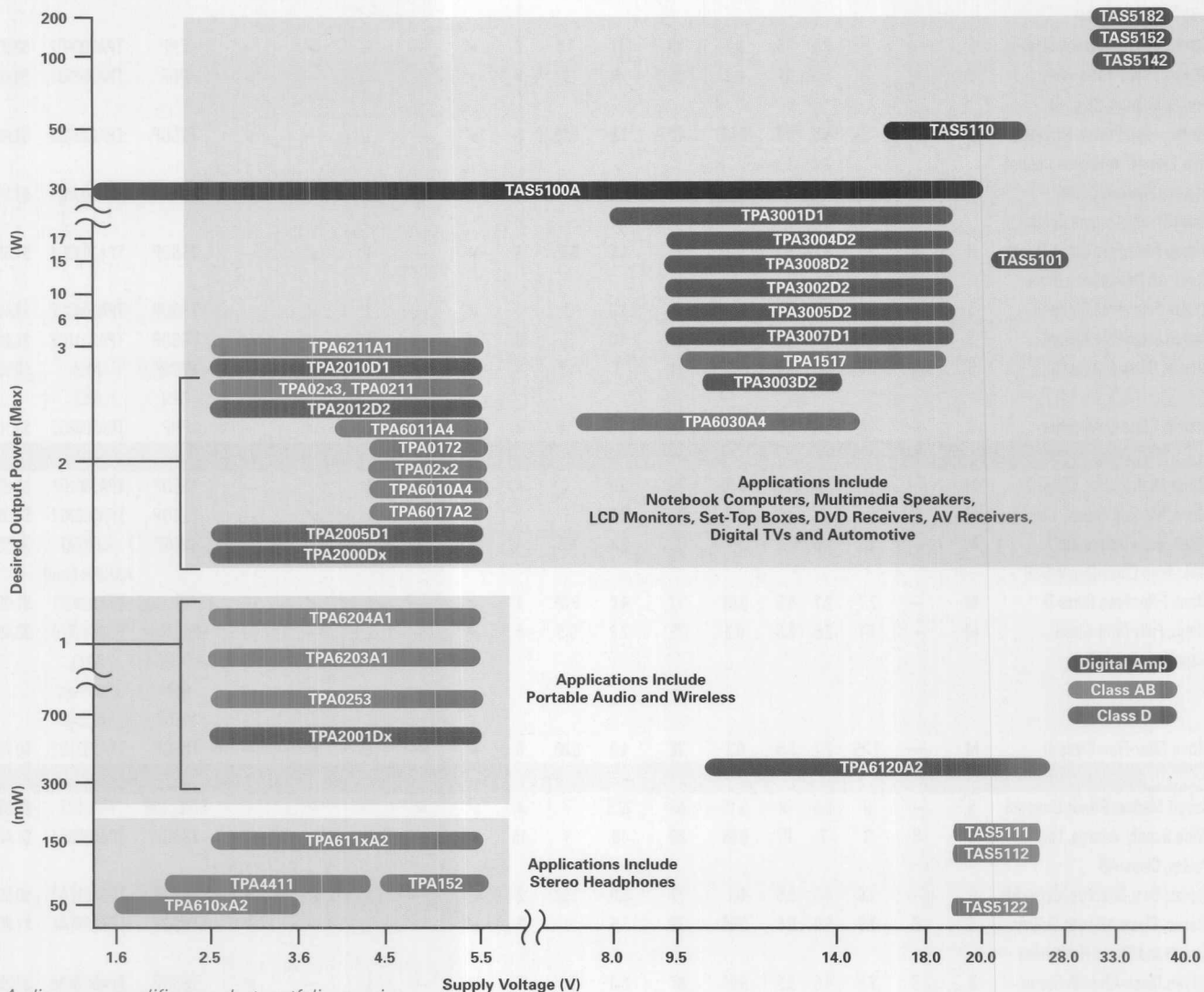


Layout—by respecting basic rules, Class-D amplifiers layout can be made easy. Decoupling caps must be close to the device, the output loop must be small to avoid the use of a filter and the differential input traces must be kept

together to limit the RF rectification. Analog V_{DD} and switching V_{DD} need to be separated back to supply source.

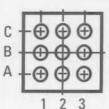
Migration path—APA products are in a constant evolution moving from Class-AB mono speaker drivers to optimized stereo

Class-D amplifiers with advanced features. The latest generation is the most cost effective for the application.



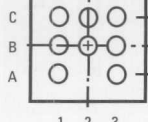
Audio power amplifiers product portfolio overview.

Audio Power Amplifiers – Packaging

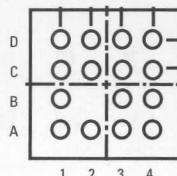
WCSP
TPA2010D1

(Bottom View)
1.45mm x 1.45mm
(0.5mm pitch)
Pb - YEF
**Pb-Free - YZF

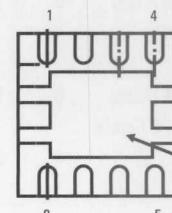
* Qualified for Pb-Free Soldering
** Pb-Free Package

BGA
TPA6203A1

(Bottom View)
2.0mm x 2.0mm
(0.5mm pitch)
*Pb - GQV
**Pb-Free - ZQV

BGA
TPA2005D1

(Bottom View)
2.5mm x 2.5mm
(0.5mm pitch)
*Pb - GQY
**Pb-Free - ZQY

SON
DFN
QFN
TPA6211A1
TPA2005D1

(Bottom View)
3.0mm x 3.0mm
(0.65mm pitch)
*Pb - DRB
**Pb-Free - ZQY

Audio Power Amplifiers Selection Guide

Device	Description	Stereo/ Mono Speaker Drive	Stereo/ Mono Head- phone Drive	Output Power (W)	V _{CC} / V _{DD} (min) & (max) (V)	Half Power THD+N at 1kHz (%)	PSRR (dB)	I _Q Per Channel (typ)(mA)	I _{SD} (μA)	Min. Load Impe- dance (Ω)	Depop	Mute	Shut- down (Active Low/ High)	Internal Gain	DC Volume Control	Package(s)	Package Symbolization	Price ¹
Class-D Stereo																		
TPA3004D2	Stereo, High Power, Class-D with Volume Control	S	—	12	8.5 18	0.1	80	8.0	1	4	✓	—	L	—	✓	PHP	TPA3004D2	\$3.50
TPA3005D2	Stereo, Medium Power, Class-D	S	—	6	8.5 18	0.1	80	11	1.6	8	✓	—	L	✓	—	PHP	TPA3005D2	\$2.95
TPA3003D2	Stereo, Low Power, Wide Supply Voltage, Class-D	S	—	3	8.5 14	0.2	80	8	1	8	✓	—	L	—	✓	PHP	TPA3003D2	\$3.00
TPA2008D2	Stereo, High Power, 5V, Filter-Free Class-D w/Volume Control	S	—	3	4.5 5.5	0.05	70	7.0	0.05	3	✓	—	L	—	✓	TSSOP	TPA2008D2	\$1.80
TPA3002D2	Stereo, Medium Power Class-D with Volume Control	S	—	9	8.5 14	0.06	80	10.0	1	8	✓	—	L	—	✓	PHP	TPA3002D2	\$3.30
TPA2000D4	Stereo Filter-Free Class-D with Class-AB Headphone Drive	S	S	2.5	3.7 5.5	0.1	70	4.5	0.05	4	✓	—	L	✓	—	TSSOP	TPA2000D4	\$1.65
TPA2000D2	Stereo Filter-Free Class-D	S	—	2.5	4.5 5.5	0.05	77	4.0	1	3	✓	—	L	✓	—	TSSOP	TPA2000D2	\$1.45
TPA2001D2	Stereo Filter-Free Class-D	S	—	1.25	4.5 5.5	0.08	77	4.0	1	8	✓	—	L	✓	—	TSSOP	TPA2001D2	\$1.20
TPA2012D2	Stereo, Class-D Amplifier	S	—	2.1	2.5 5.5	1.0	71	3	1.5	4	✓	—	L	✓	—	WCSP QFN	AKR AKS	\$0.95
TPA3008D2	Stereo, Class-D Amplifier	S	—	10	8.5 18	0.1	80	11	1.6	8	✓	—	L	✓	—	PHP	TPA3008D2	\$3.10
Class-D Mono																		
TPA3001D1	Mono, High Power, Class-D	M	—	20	8 18	0.06	73	8.0	1	4	✓	—	L	✓	—	TSSOP	TPA3001D1	\$2.85
TPA3007D1	Mono, Medium Power, Class-D	M	—	6.5	8 18	0.3	73	8.0	1	7	✓	—	L	✓	—	TSSOP	TPA3007D1	\$1.95
TPA2010D1	Mono, Fully Differential, Filter-Free Class-D in WCSP	M	—	2.5	2.5 5.5	0.2	75	2.8	0.5	4	✓	—	L	—	—	WCSP	AJZ(Pb) AKO(Pb-Free)	\$0.55
TPA2000D1	Mono Filter-Free Class-D	M	—	2.7	2.7 5.5	0.08	77	4.0	0.05	4	✓	—	L	✓	—	TSSOP, GQC	TPA2000D1	\$1.05
TPA2005D1	Mono, Fully Differential, Filter-Free Class-D	M	—	1.1	2.5 5.5	0.2	75	2.8	0.5	8	✓	—	L	—	—	MicroStar Jr. TM BGA QFN MSOP	PB051 (Pb) AAFI (Pb-Free) BIQ, BAL	\$0.49
TPA2001D1	Mono Filter-Free Class-D	M	—	1.25	2.7 5.5	0.2	72	4.0	0.05	8	✓	—	L	✓	—	TSSOP	TPA2001D1	\$0.75
Class-AB Stereo																		
TPA1517	Stereo, Medium Power, Class-AB	S	—	6	9.5 18	0.15	65	22.5	7	4	✓	✓	—	✓	—	SOIC, DIP	TPA1517	\$0.85
TPA6030A4	Wide Supply Voltage, Low Power, Class-AB	S	S	3	7 15	0.06	60	18	1	16	✓	—	L	—	✓	TSSOP	TPA6030A4	\$1.40
TPA6017A2	Stereo, Cost-Effective, Class-AB	S	—	2.6	4.5 5.5	0.1	77	3.0	150	3	✓	—	L	✓	—	TSSOP	TPA6017A2	\$0.99
TPA6011A4	Stereo, Class-AB with Volume Control and Stereo Headphone	S	S	2.6	4.0 5.5	0.06	70	7.5	1	3	✓	—	L	—	✓	TSSOP	TPA6011A4	\$1.20
TPA6010A4	Stereo Class-AB with Stereo Headphone Drive, Volume Control and Bass Boost	S	S	2.6	4.5 5.5	0.06	67	6.0	60	3	✓	—	L	—	✓	TSSOP	TPA6010A4	\$2.25
TPA0252 ²	Stereo Class-AB with Stereo Headphone Drive, Volume Control Memory	S	S	2.8	4.5 5.5	0.06	67	4.5	150	3	✓	—	L	—	—	TSSOP	TPA0252	\$1.80
TPA0212	Stereo Class-AB with Stereo Headphone Drive and Integrated Gain	S	S	2.6	4.5 5.5	0.15	77	3.0	150	3	✓	—	L	✓	—	TSSOP	TPA0212	\$1.10
TPA01722	Stereo Class-AB with Stereo Headphone Drive & I ² C Control	S	S	2.0	4.5 5.5	0.08	75	4.0	15	4	✓	✓	L	—	—	TSSOP	TPA0172	\$2.45
TPA6112A2	Stereo, Differential Input, Headphone	—	S	0.15	2.5 5.5	0.25	83	0.75	10	8	✓	—	H	—	—	MSOP	APD	\$0.39

¹ Suggested resale price in U.S. dollars in quantities of 1,000. ² Includes digital volume control.

Preview products are listed in **bold blue**.

Audio Power Amplifiers



Audio Power Amplifiers Selection Guide (Continued)

		Stereo/ Mono Speaker Drive	Stereo/ Mono Head- phone Drive	Output Power (W)	V _{CC} / V _{DD} (min) & (max) (V)	Half Power THD+N at 1kHz (%)	PSRR (dB)	I _O Per Channel (typ)(mA)	I _{SD} (μA)	Min. Load Impe- dance (Ω)	Depop	Mute	Shut- down (Active Low/ High)	Internal Gain	DC Volume Control	Package(s)	Package Symbolization	Price¹	
Device	Description																		
Class-AB Stereo (Continued)																			
TPA6111A2	Stereo Headphone, Pin Compatible with LM4880 and LM4881	—	S	0.15	2.5	5.5	0.25	83	0.75	1	8	✓	—	H	—	—	SOIC MSOP	TPA6111A2 AJA	\$0.29
TPA6110A2	Stereo Headphone, Pin Compatible with LM4881	—	S	0.15	2.5	5.5	0.25	83	0.75	10	8	✓	—	H	—	—	MSOP	AIZ	\$0.39
TPA152	Hi-Fi, Stereo Headphone	—	S	0.075	4.5	5.5	0.007	81	2.8	—	32	✓	✓	—	—	—	SOIC	TPA152	\$0.55
TPA6102A2	Ultra Low Voltage, Stereo Headphone w/Fixed Gain (14dB)	—	S	0.05	1.6	3.6	0.1	72	0.32	0.05	16	✓	—	L	—	—	SOIC MSOP	TPA6102A2 AJN	\$0.35
TPA6101A2	Ultra Low Voltage, Stereo Headphone w/Fixed Gain (2dB)	—	S	0.05	1.6	3.6	0.1	72	0.32	0.05	16	✓	—	L	—	—	SOIC MSOP	TPA6101A2 AJM	\$0.35
TPA6100A2	Ultra Low Voltage Stereo Headphone	—	S	0.05	1.6	3.6	0.1	72	0.38	0.05	16	✓	—	L	—	—	SOIC MSOP	TPA6100A2 AJL	\$0.35
TPA4411	Cap-Free Stereo Headphone Amplifier	—	S	0.08	1.8	4.5	0.08	80	3.5	0.1	16	✓	—	L	✓	—	WCSP QFN	AKT AKQ	\$0.70
TPA6120A2	High-Fidelity Stereo Headphone Driver	—	S	1.5	10	30	0.0005	75	11.5	—	32	—	—	—	—	—	HSOP	TPA6120A2	\$1.90
Class-AB Mono																			
TPA6211A1	High Power, 5V Mono, Class-AB, Fully Differential	M	—	3.1	2.5	5.5	0.02	85	4.0	0.01	3	✓	—	L	—	—	MSOP QFN	AYK AYN	\$0.55
TPA0233	Mono Class-AB with Stereo Headphone Drive— Summed Inputs	M	S	2.7	2.5	5.5	0.06	58	3.3	1	4	✓	—	L	—	—	MSOP	AEJ	\$1.15
TPA0213	Mono Class-AB with Stereo Headphone Drive— Separate Inputs	M	S	2.7	2.5	5.5	0.06	65	3.6	1	4	✓	—	L	—	—	MSOP	AEH	\$1.15
TPA0211	Mono Class-AB with Mono Headphone Drive	M	M	2.7	2.5	5.5	0.06	58	4.0	1	4	✓	—	L	—	—	MSOP	AEG	\$0.70
TPA6203A1	Mono, Fully Differential, Class-AB	M	—	1.5	2.5	5.5	0.06	90	1.7	0.01	8	✓	—	L	—	—	MicroStar Jr.™ BGA	AADI (Pb) AAEI (Pb-Free)	\$0.45
TPA0253	Mono, Low Power, Class-AB with Stereo Headphone Drive—Summing Inputs	M	S	1.25	2.5	5.5	0.1	65	2.7	1	8	✓	—	L	—	—	MSOP	AEL	\$1.00
TPA751	Mono, Differential Input, Class-AB with Active Low Shutdown	M	—	0.9	2.5	5.5	0.15	85	1.25	0.0015	8	—	—	L	—	—	SOIC MSOP BGA	TPA751 ATC	\$0.43
TPA741	Mono, Differential Input, Class-AB with Active High Shutdown and Depop	M	—	0.9	2.5	5.5	0.15	85	1.35	7	8	✓	—	H	—	—	SOIC MSOP	TPA741 AJD	\$0.43
TPA731	Mono, Differential Input, Class-AB with Active High Shutdown	M	—	0.9	2.5	5.5	0.15	85	1.25	0.0015	8	—	—	H	—	—	SOIC MSOP	TPA731 AJC	\$0.43
TPA721	Mono Class-AB with Active High Shutdown	M	—	0.9	2.5	5.5	0.15	85	1.25	7	8	✓	—	H	—	—	SOIC MSOP	TPA721 ABC	\$0.43
TPA711	Mono Class-AB with Mono Headphone Drive	M	M	0.9	2.5	5.5	0.15	85	1.25	7	8	✓	—	H	—	—	SOIC MSOP	TPA711 ABB	\$0.43
TPA6204A1	Mono Class-AB Amplifier	M	—	1.7	2.5	5.5	0.0018	85	4.0	0.01	8	✓	—	L	—	—	QFN	AYJ	\$0.50

¹ Suggested resale price in U.S. dollars in quantities of 1,000.Preview products are listed in **bold blue**.



Audio Amplifiers

Audio Signal Amplifiers Selection Guide

Device	Description	Channels	Supply Voltage (V)	THD+N (%)	Slew Rate (V/ μ s)	GBW (MHz)	Package(s)	Price ¹
Operational Amplifiers								
OPA1632	Fully Differential Audio ADC Driver	1	± 2.5 to ± 16	0.00022	50	180	MSOP-8 PowerPAD™, SOIC	\$1.75
OPAy363	1.8V, 90dB typ CMRR, RRIO, SHDN, SS	1, 2	1.8 to 5.5	—	5	7	SOT23, MSOP, SOIC	\$0.60
OPAy353	CMOS, Single Supply, High Speed	1, 2, 4	2.7 to 5.5	0.0006	22	44	SOT23, MSOP, TSSOP, SOIC	\$1.00
TLV246x	11pV/ $\sqrt{\text{Hz}}$ Noise, Low Cost, High Drive	1, 2, 4	2.7 to 6	0.004	1.6	6.4	SOT23, TSSOP, SO, DIP	\$0.60
OPAy604	FET-Input	1, 2	± 4.5 to ± 24	0.0003	25	20	DIP, SOIC	\$1.05
OPAy134	FET-Input	1, 2, 4	± 2.5 to ± 18	0.00008	20	8	DIP, SOIC	\$0.95
OPAy227	Low Noise	1, 2, 4	± 2.5 to ± 18	0.00005	2.3	8	DIP, SOIC	\$1.65
OPAy228	Low Noise	1, 2, 4	± 2.5 to ± 18	0.00005	10	33	DIP, SOIC	\$1.10
OPAy627	Ultra-High Performance, DiFET	1	± 4.5 to ± 18	0.00003	55	16	DIP, SOIC	\$12.25
OPAy637	Ultra-High Performance, DiFET, $G \geq 5$	1	± 4.5 to ± 18	0.00003	135	80	DIP, SOIC	\$12.25
Line Drivers and Receivers								
DRV134	Professional Line Transmitter	1	± 4.5 to ± 18	0.0005	12	1.5	DIP, SOIC, SOL	\$1.95
DRV135	Professional Line Transmitter	1	± 4.5 to ± 18	0.0005	12	1.5	DIP, SOIC, SOL	\$1.95
INA134	Professional Line Receiver, Low Distortion, $G = 1$	1	± 4 to ± 18	0.0005	14	3.1	DIP, SOIC	\$1.05
INA2134	Dual INA134	2	± 4 to ± 18	—	14	3.1	DIP, SOIC	\$1.70
INA137	Professional Line Receiver, $G = 0.5$ or 2	1	± 4 to ± 18	0.0005	14	4	DIP, SOIC	\$1.05
INA2137	Dual INA137	2	± 4 to ± 18	0.0005	14	4	DIP, SOIC	\$1.70
Microphone Preamplifiers								
INA163	Low Noise, High Performance	1	± 4.5 to ± 18	0.002	15	8	SO-14	\$2.50
INA166	Low Noise, Fixed-Gain, 2000V/V	1	± 4.5 to ± 18	—	15	4.5	SO-14	\$5.95
INA103	High Performance, Low Distortion	1	± 9 to ± 25	—	15	8	DIP, SOL-16	\$5.00
INA217	Low Noise	1	± 4.5 to ± 18	0.004	15	8	DIP, SOIC	\$2.50
Volume Controls								
PGA2310	BiCMOS, Stereo Audio Volume Control	2	± 15	0.0004	—	—	SOL-16, DIP-16	\$9.95
PGA2320	BiCMOS, Stereo Audio Volume Control	2	± 15	0.0004	—	—	SOL-16	\$8.50
PGA2311	CMOS, Stereo Audio Volume Control	2	± 5	0.0002	—	—	SOL-16, DIP-16	\$5.20
PGA4311	CMOS, 4-Channel Audio Volume Control	4	± 5	0.0002	—	—	SOP-28	\$8.90

¹ Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**.

Digitally Controlled Microphone Preamplifiers Selection Guide

Device	Description	Gain Range (dB)	Noise (E_{IN}) $G = 30\text{dB}$	THD+N with Gain = 30dB (%)	Power Supply (V)	Package	Price ¹
PGA2500	Digitally Controlled Mic Preamp	0dB and 10dB to 65dB in 1dB Steps	-128dBu	0.0004	± 5	SSOP-28	\$9.95

¹ Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**.

Digital Audio Pulse Width Modulation Processors Selection Guide

Device	Channels	Sample Frequency (kHz)	Dynamic Range (dB)	Audio Controls	THD+N (% of System Performance)	Bits	Package	Price ¹
TAS5026A	6	32 to 192	96	—	<0.08	16, 20, 24	PQFP-64	\$5.75
TAS5036B	6	32 to 192	100	—	<0.08	16, 20, 24	PQFP-80	\$10.45
TAS5010	2	32 to 192	96	—	<0.08	16, 20, 24	PQFP-48	\$3.00
TAS5012	2	32 to 192	102	—	<0.08	16, 20, 24	PQFP-48	\$5.55
TAS5504	4	32 to 192	102	Volume, Audio Filters	<0.1	16, 20, 24	PQFP-64	\$4.30
TAS5508	8	32 to 192	100	Volume, Audio Filters	<0.1	16, 20, 24	PQFP-64	\$6.30
TAS5066	6	32 to 192	98	Volume	<0.1	16, 20, 24	PQFP-64	\$5.75
TAS5076	6	32 to 192	105	Volume	<0.1	16, 20, 24	PQFP-80	\$12.35
TAS5086	6	32 to 192	100	Volume, Bass Mgmt.	<0.1	16, 20, 24	TSSOP-32	\$1.60

¹ Suggested resale price in U.S. dollars in quantities of 1,000.Preview products are listed in **bold blue**.



Digital Amplifiers Power Stage Selection Guide

Device	Power	Channels	Sampling Frequency	THD+N	Package(s)	Price ¹
TAS5111	70W (4Ω)	1	32 to 192	<0.1	32-PowerPAD™	\$2.40
TAS5112	50W (6Ω)	2	32 to 192	<0.1	56-PowerPAD	\$4.15
TAS5121	100W (4Ω)	1	32 to 192	<0.1	32-PSOP	\$3.50
TAS5122	30W (6Ω)	2	32 to 192	<0.1	56-PowerPAD	\$3.65
TAS5142	100W (4Ω)	2	192 to 384	<0.1	36-SSOP	\$3.90
TAS5152	125W (4Ω)	2	192 to 384	<0.1	36-SSOP	\$4.30
TAS5182	100W (6Ω)	2	32 to 192	<0.1	56-PowerPAD	\$5.30
TAS5186	36/60W (6/3Ω)	6	32 to 192	<0.1	44-PowerPAD, 36-PSOP	\$5.10

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in **bold red**.

Digitally Controlled Microphone Preamplifier PGA2500

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/PGA2500

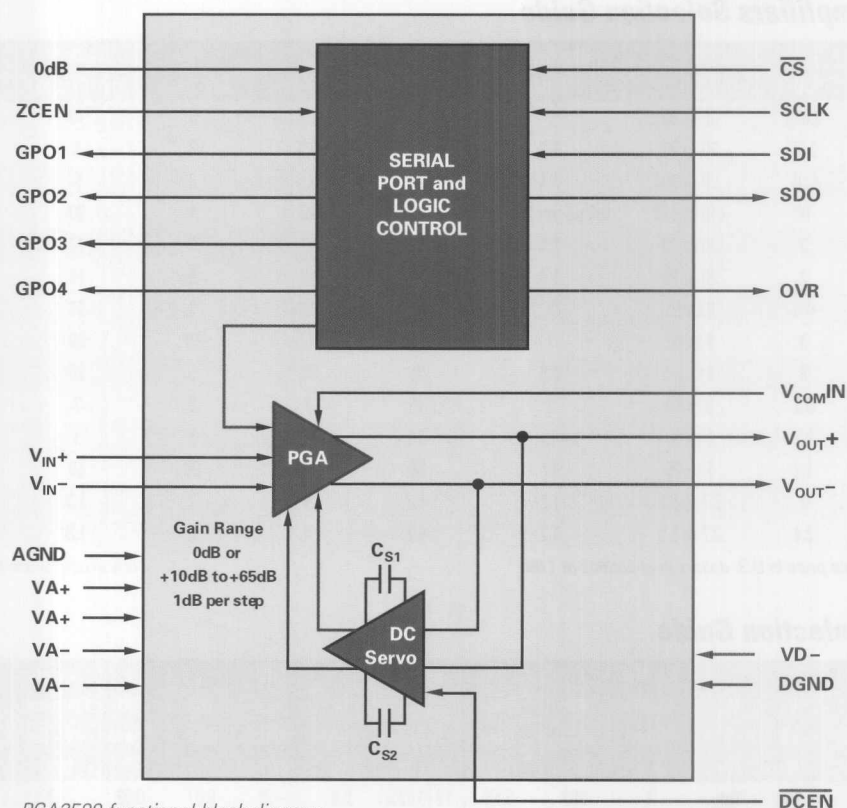
Key Features

- 0dB, 10dB to 65dB in 1dB steps
- Fully differential I/O
- Dynamic performance
 - Equivalent input noise of -128dBu with $Z_S = 150\Omega$; Gain = 30dB
 - THD+N of 0.0004% with Gain = 30dB
- Includes DC servo
- Common-mode servo improves CMRR
- Four general-purpose digital outputs
- Serial interface
- $\pm 5\text{V}$ supply
- Packaging: 28-lead SSOP

Applications

- Microphone preamplifiers and mixers
- Digital mixers and recorders

The PGA2500 is a digitally controlled, analog microphone preamplifier designed for use as a front end for high-performance audio ADCs. The PGA2500 features include low noise, wide dynamic range, and a differential signal path. An on-chip DC servo loop is employed to minimize DC offset, while a common-mode servo function may be used to enhance common-mode rejection.



PGA2500 functional block diagram.



Power Amplifiers and Buffers

TI power amplifiers solve tough high-voltage and high-current design problems in applications requiring up to 80V and 10A output current. Most are internally protected against thermal and current overload, and some offer user-defined current limiting. The unity-gain buffer amplifier series provides slew rates up to 3600V/ μ s and output current to 250mA.

Design Considerations

Power dissipation—determines the appropriate package type as well as the size of the required heat sink. Always stay within the specified operating range to maintain reliability of the power amps. Some power amps are internally protected against overheating and overcurrent. The thermally-enhanced PowerPAD™ package provides greater design flexibility and increased thermal efficiency in a

standard size IC package. PowerPAD provides an extremely low thermal resistance path to a ground plane or special heatsink structure.

Full-power bandwidth—or large-signal bandwidth, high FPBW is achieved by using power amps with high slew rate.

Current limit—be aware of the specified operating area, which defines the relationship between supply voltage and current output. Both power supply and load must be appropriately selected to avoid thermal and current limits.

Thermal shutdown—the incorporation of internal thermal sensing and shut-off will automatically shut-off the amplifier should the internal temperature reach a specified value.

Technical Information

Power Amps

Unlike other designs using a power resistor in series with the output current path, the OPA547, OPA548 and OPA549 power amps sense current internally. This allows the current limit to be adjusted from near 0A to the upper limit with a control signal or a low-power resistor. This feature is included in the OPA56x series. The new 2A OPA567 comes in the tiny QFN package.

Buffers

The BUF634 can be used inside the feedback loop to increase output current, eliminate thermal feedback and improve capacitive load drive. When connected inside the feedback loop, the offset voltage and other errors are corrected by the feedback of the op amp.

Power Amplifiers Selection Guide

Device	I _{OUT} (A)	V _S (V)	Bandwidth (MHz)	Slew Rate (V/ μ s)	I _Q (mA) (max)	V _{OS} (mV) (max)	V _O Drift (μ V/ $^{\circ}$ C) (max)	I _B (nA) (max)	Package(s)	Price ¹
OPA445/B	0.015	20 to 90	2	15	4.7	3	10	0.05	DIP8, SO8	\$4.75
OPA452	0.05	20 to 80	1.8	7.2	5.5	3	5	0.1	T0220-7, DDPak-7	\$2.61
OPA453	0.05	20 to 80	7.5	23	5.5	3	5	0.1	T0220-7, DDPak-7	\$2.61
OPA541	10	\pm 10 to \pm 40	full power 55kHz	10	20	1	30	0.05	ZIP	\$11.10
OPA544	2	20 to 70	1.4	8	12	5	10	0.1	T0220-5, DDPak-5	\$6.85
OPA2544	2	20 to 70	1.4	8	12	5	10	0.1	ZIP11	\$12.00
OPA547	0.5	8 to 60	1	6	10	5	25	500	T0220-7, DDPak-7	\$4.35
OPA548	3	8 to 60	1	10	17	10	30	500	T0220-7, DDPak-7	\$6.00
OPA549	8	8 to 60	0.9	9	26	5	20	500	ZIP11	\$12.00
OPA551	0.2	8 to 60	3	15	7	3	7	0.1	DIP8, SO8, DDPak-7	\$1.99
OPA552	0.2	8 to 60	12	24	7	3	7	0.1	DIP8, SO8, DDPak-7	\$1.99
OPA561	1.2	7 to 16	17	50	50	20	50	0.1	HTSSOP-20	\$2.50
OPA567	2	2.7 to 5.5	1.2	1.2	6	2	1.3	0.05	QFN-12 PowerPAD™	\$1.85
OPA569	2.4	2.7 to 5.5	1.2	1.2	6	2	1.3	0.01	SO-20, PowerPAD	\$3.10

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in **bold red**. Preview products are listed in **bold blue**.

Buffers Selection Guide

Device	V _S \pm 15 (V)	V _S \pm 5 (V)	V _S 5 (V)	A _{CL} Min Stable Gain (V/V)	BW at A _{CL} (MHz)	Slew Rate (V/ μ s)	Settling Time (0.01%) (ns) (typ)	I _Q (mA) (typ)	THD (F _C = 1MHz) (dB) (typ)	Diff Gain (%)	Diff Phase ($^{\circ}$)	V _{IN} at Flatband (nV/ \sqrt Hz) (typ)	V _{OS} (mV) (max)	I _B (μ A) (max)	Package(s)	Price ¹
OPA692	—	Yes	Yes	1	280	2000	12 [0.02%]	5.8	−78	0.07	0.02	1.7	2.5	45	SOT23, SOIC	\$1.45
THS3202	—	Yes	—	1	2000	9000	118	20	−86	0.008	0.03	1.65	5	50	MSOP, HTSSOP, SOIC	\$2.90
OPA832	—	Yes	Yes	1	92	350	45 [0.1%]	5.9	−84	0.1	0.16	9.3	5	0.01	SOT23, SOIC	\$0.70
BUF634	Yes	Yes	Yes	1	180	2000	200	250	—	0.4	0.1	4	100	20	DIP, SOIC, T0220-5, DDPak-5	\$3.05
OPA633	Yes	Yes	—	1	260	2500	50	100	—	—	0.1	—	15	35	DIP	\$5.45

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Pulse Width Modulation Power Drivers

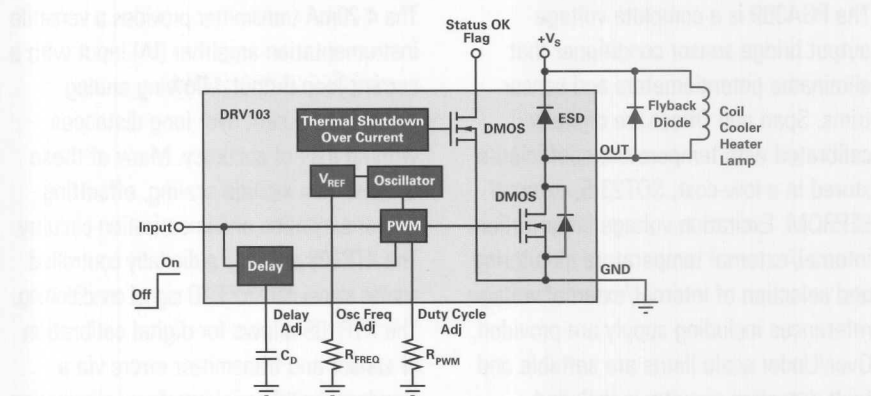


TI's pulse width modulation (PWM) power drivers are specifically designed for applications requiring high current at low to moderately high voltages, ranging from 5V to 60V. Loads include electro-mechanical loads, such as solenoids, coils, actuators, and relays, as well as heaters, lamps, thermoelectric coolers, and laser diode pumps.

These products feature integrated power transistors, which save considerable circuit board area compared to discrete implementations. Unlike the operation of linear drivers, PWM operation offers efficiencies as great as 90%, resulting in less power wasted as heat and reduced demand on the power supply. The DRV10x operates from +8V to +60V and has a single low-side or high-side power switch. The devices in the DRV59x family may be analog or digitally controlled and operate from 0% to 100% duty cycles. The DRV59x operates on +2.8V to +5.5V and has internal H-bridge output switches in series with the load, allowing for bi-directional current flow from a single power supply.

Design Considerations

Supply voltage—selection begins with the power supply voltages available in the system. TI's family of PWM power drivers operate from 2.8V to 5.5V.



DRV103 low-side PWM driver block diagram.

Output current and output voltage—the load to be connected to the power driver will also help determine the proper PWM power driver solution. The maximum output current required by the load should be known. The maximum output voltage capability of the driver may be calculated as follows:

$$V_O (\text{max}) = V_S - [I_O (\text{max}) \cdot 2 \cdot R_{DS(ON)}]$$

Efficiency—a lower on-resistance (R_{ON}) of the output power transistors will yield greater efficiency. Typically, $R_{DS(ON)}$ is specified per transistor. In an H-bridge output configuration, two output transistors are in series with the load. To quickly estimate the efficiency, use the following equation:

$$\text{Efficiency} = R_L / [R_L + (2 \cdot R_{DS(ON)})]$$

Analog or digital control—the DRV590, DRV591, DRV593 and DRV594 each accept a DC voltage input signal, either

from an analog control loop (i.e., PID controller) or from a DAC, while the DRV592 accepts a PWM input signal.

Output filter—in some applications, a low-pass filter is placed between each output of the PWM driver and the load to remove the switching frequency components. A second-order filter consisting of an inductor and capacitor is commonly used, with the cut-off frequency of the filter typically chosen to be at least an order of magnitude lower than the switching frequency. For example, a DRV593 switching at 500kHz can have a 15.9kHz cut-off frequency. The component values are calculated using the following formula:

$$FC = 1 / [2 \cdot \pi \cdot (\sqrt{L \cdot C})]$$

The inductor value is typically chosen to be as large as possible, and is then used to calculate the required capacitor value for the desired cut-off frequency.

PWM Power Drivers Selection Guide

Device	Description	Supply Voltage (V)	Output Current (V) typ	Saturation Voltage (V)	R_{ON} (Ω)	Switching Frequency (kHz)	Package(s)	Price ¹
Single Switch								
DRV101	Low-Side with Internal Monitoring	9 to 60	2.3	1.6	0.8	25	T0-220, DPAK	\$3.85
DRV102	High-Side with Internal Monitoring	8 to 60	2.7	1.9	0.95	25	T0-220, DPAK	\$3.85
DRV103	Low-Side with Internal Monitoring	8 to 32	3	0.9	0.9	0.5 - 100*	SO-8, SO-8 PowerPAD™	\$1.60
DRV104	High-Side with Internal Monitoring	8 to 32	2	0.45	0.2	0.5 - 100*	HTSSOP-14 PowerPAD	\$1.60
Bridge								
DRV590	H-Bridge	2.8 to 5.5	1.2	0.48	0.4	500	PowerPAD, SOIC, TSSOP 4x4mm MicroStar Junior™	\$7.30
DRV591	H-Bridge with Internal Monitoring	2.8 to 5.5	3	0.195	0.065	100/500	9x9 PowerPAD QFP	\$6.30
DRV592	H-Bridge with Internal Monitoring	2.8 to 5.5	3	0.195	0.065	1000	9x9 PowerPAD QFP	\$12.50
DRV593	H-Bridge with Internal Monitoring	2.8 to 5.5	3	0.195	0.065	100/500	9x9 PowerPAD QFP	\$5.90
DRV594	H-Bridge with Internal Monitoring	2.8 to 5.5	3	0.195	0.065	100/500	9x9 PowerPAD QFP	\$5.90

¹Suggested resale price in U.S. dollars in quantities of 1,000. *Adjustable internal oscillator frequency

New products are listed in bold red.

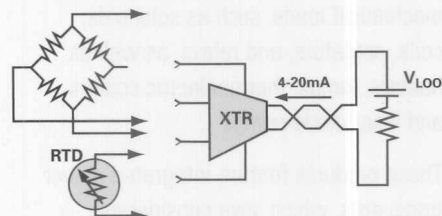


Sensor Conditioners and 4-20mA Transmitters

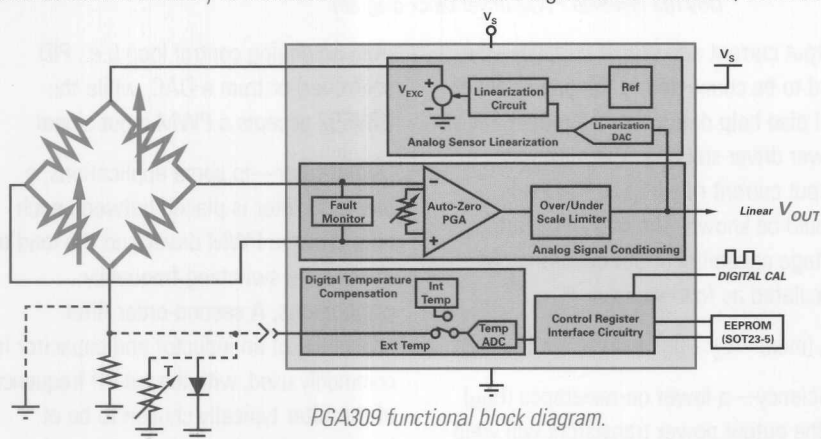
The PGA309 is a complete voltage output bridge sensor conditioner that eliminates potentiometers and sensor trims. Span and Offset are digitally calibrated with temperature coefficients stored in a low-cost, SOT23-5, external EEPROM. Excitation voltage linearization, internal/external temperature monitoring and selection of internal/external voltage references including supply are provided. Over/Under scale limits are settable and fault detection circuitry is included.

The 4-20mA transmitter provides a versatile instrumentation amplifier (IA) input with a current-loop output, allowing analog signals to be sent over long distances without loss of accuracy. Many of these devices also include scaling, offsetting, sensor excitation and linearization circuitry. The XTR108 provides a digitally controlled analog signal path for RTD signal conditioning. The XTR108 allows for digital calibration of sensor and transmitter errors via a standard digital serial interface, eliminating

expensive potentiometers or circuit value changes. Calibration settings can be stored in an inexpensive external EEPROM for easy retrieval during routine operation.



4-20mA transmitter design solutions.



PGA309 functional block diagram.

PGA309 Key Features

- Voltage output: ratiometric or absolute
- Digital calibration: no potentiometers, no sensor trim
- Sensor compensation: span and span drift, offset and offset drift
- <0.1% post-cal accuracy
- 2.7 to 5.5V operation
- Packaging: TSSOP-16

4-20mA Transmitters and Receiver Selection Guide

Device	Description	Sensor Excitation	Loop Voltage (V)	Full-Scale Input Range	Output Range (mA)	Additional Power Available (V at mA)	Package(s)	Price ¹	
2-Wire 4-20mA Transmitters									
XTR105	100Ω RTD Conditioner with Linearization	Two 800μA	7.5 to 36	5mV to 1V	4-20	5.1 at 1	DIP-14, SOIC-14	\$4.00	
XTR106	Bridge Conditioner with Linearization	5V and 2.5V	7.5 to 36	5mV to 1V	4-20	5.1 at 1	DIP-14, SOIC-14	\$4.00	
XTR108	10Ω to 10kΩ RTD Conditioner, 6-Channel Input Mux, Extra Op Amp Can Convert to Voltage Sensor Excitation, Calibration Stored in External EEPROM	Two 500μA	7.5 to 24	5mV to 320mV	4-20	5.1 at 2.1	SSOP-24	\$3.35	
XTR112	1kΩ RTD Conditioner with Linearization	Two 250μA	7.5 to 36	5mV to 1V	4-20	5.1 at 1	DIP-14, SOIC-14	\$4.00	
XTR114	10kΩ RTD Conditioner with Linearization	Two 100μA	7.5 to 36	5mV to 1V	4-20	5.1 at 1	DIP-14, SOIC-14	\$4.00	
XTR115	I _{IN} to I _{OUT} Converter, External Resistor Scales V _{IN} to I _{IN}	V _{REF} = 2.5V	7.5 to 36	40μA to 200μA	4-20	5.0 at 3.7	SOIC-8	\$1.05	
XTR116	I _{IN} to I _{OUT} Converter, External Resistor Scales V _{IN} to I _{IN}	V _{REF} = 4.096V	7.5 to 36	40μA to 200μA	4-20	5.0 at 3.7	SOIC-8	\$1.05	
Bridge Conditioner with Digital Calibration for Linearization, Span and Offset over Temperature									
PGA309	Complete Digitally Calibrated Bridge Sensor Conditioner, Voltage Output, Calibration Stored in External EEPROM, One-Wire/Two-Wire Interface	V _{EXC} = V _S , 2.5V 4.096V	2.7V to 5.5V	1mV/V to 245mV/V	0.1V to 4.9V at V _S = +5V	—	TSSOP-16	\$3.40	
Industrial Current/Voltage Drivers									
XTR110	0-20mA, 4-20mA Current Driver	V _{REF} = 10V	13.5 to 40	0V to 5V, 0V to 10V	4-20, 0-20, 5-25	—	DIP-16	\$7.10	
XTR300	Programmable I/O Driver for all Industrial Voltage and Current Output	Digitally selected V _O ≤ ±15V or I _O ≤ ±25mA					QFN-20	—	
4-20mA Current Loop Receiver									
RCV420	4-20mA Input, 0V to 5V Output, 1.5V Loop Drop	V _{REF} = 10V	+11.5/-5 to ±18	4-20mA	0V to 5V	—	DIP-16	\$3.55	

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Preview products are listed in **bold blue**.

Sensor Conditioners and 4-20mA Transmitters

Industrial Analog Voltage/Current Driver
XTR300

Get samples, datasheets, EVMs and app reports at:

www.ti.com/sc/device/XTR300

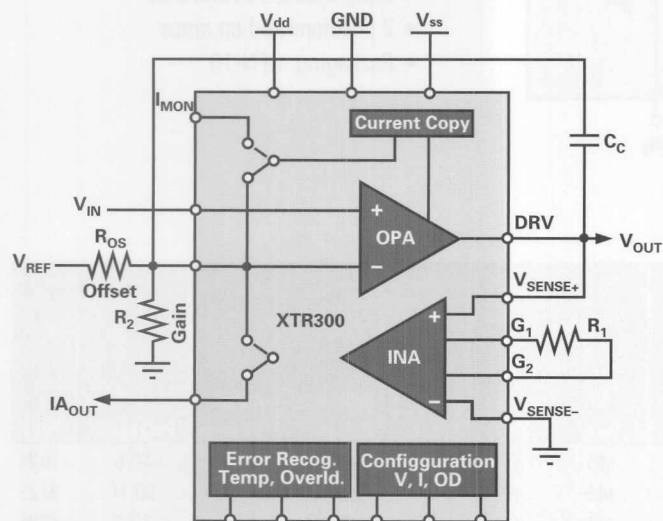
The XTR300 is a complete output driver for industrial and process control applications. The output can be selected as current or voltage by the I/V select pin, without the use of an external resistor. Separate driver and receiver channels are provided for added flexibility. The integrated instrumentation amplifier (INA) can be used for remote voltage sensing or as a high-voltage, high-impedance measurement channel. In voltage output mode, a copy of the output current is provided; error flags allow for convenient fault detection. For additional protection, maximum output current limit and thermal shutdown is provided.

Key Features

- Pin select I or V output or input
- Pin select for output enable/disable (OE)
- Gain or transconductance set by external resistors
- Output voltage swing: ± 16 at $V_S = \pm 19$ V
- Output current: ± 24 mA (linear range)
- Packaging: 5mm x 5mm QFN-20

Applications

- Analog interface between industrial high-voltage and low-voltage signal processing: PLC – I/O, Field Bus I/O



XTR300 functional block diagram.

Programmable 4-20mA Transmitter with Programmable Signal Conditioning
XTR108

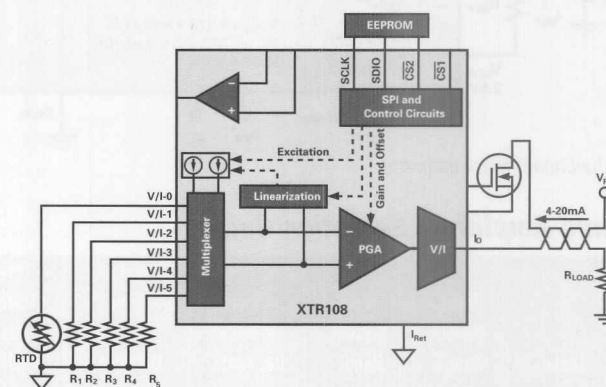
Get samples, datasheets and app reports at:

www.ti.com/sc/device/XTR108

The XTR108 is a new-generation programmable 4-20mA current loop transmitter. Its basic function is similar to TI's all-analog types, but the XTR108 has a digitally adjustable analog signal path that provides improved accuracy and lower cost. Digital calibration avoids potentiometers, component substitution and other expensive adjustment methods that are often difficult to calibrate manually. The XTR108 is designed for RTD temperature sensors, but it can be used with many other sensor types including metal and silicon pressure bridges. It incorporates an input and excitation multiplexer, auto-zeroed programmable-gain amplifier (PGA), current and voltage references, linearization circuitry and a voltage-to-current converter output stage.

Key Features

- Complete 4-20mA transmitter function
- Voltage output pin for intermediate conditioning
- No potentiometers or manual trimming
- Serial SPI bus interface
- Uncommitted op amp for 4-wire RTD connections
- 5V sub-regulator for powering external circuitry
- Packaging: SSOP-24



XTR108 functional block diagram.



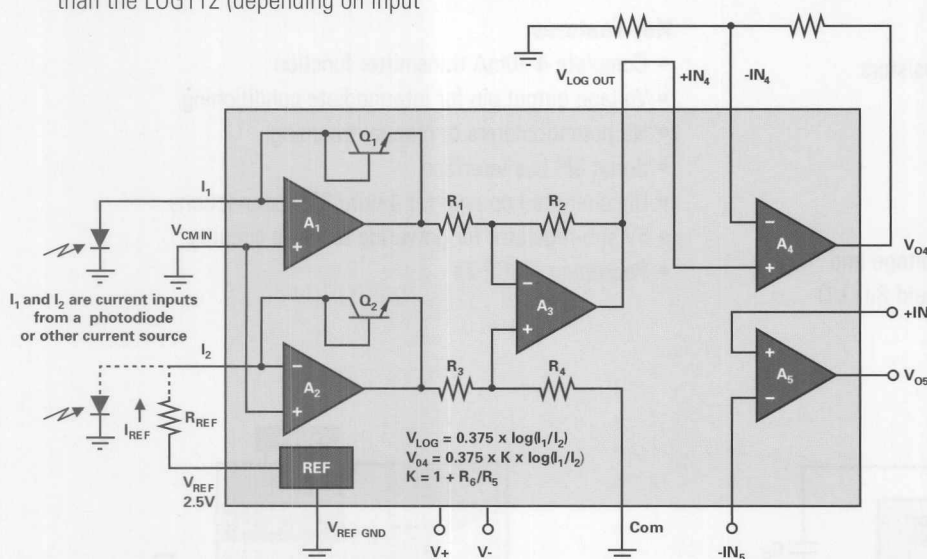
Logarithmic Amplifiers

TI has achieved significant advancement in log amp technology. The logarithmic amplifier is a versatile integrated circuit that computes the logarithm of an input current relative to a reference current or the log of the ratio of two input currents. Logarithmic amplifiers can compress an extremely wide input dynamic range (up to 8 decades) into an easily measured output voltage. Accurate matched bipolar transistors provide excellent logarithmic conformity over a wide input current range. On-chip compensation achieves accurate scaling over a wide operating temperature range.

The new 5MHz LOG114 can operate on a 5V single supply. It offers 100 to 500 times higher transimpedance bandwidth than the LOG112 (depending on input

current level) and up to 8 decades of dynamic range. The LOG114 is available in a tiny QFN-16 package.

TI log amplifiers are designed for optical networking, photodiode signal compression, analog signal compression and logarithmic computation for instrumentation. Some log amps, such as the LOG102, feature additional uncommitted op amps for use in a variety of functions including gain scaling, inverting, filtering, offsetting and level comparison to detect loss of signal. The LOG2112 is a dual version of the LOG112 and includes two log amps, two uncommitted output amps and a single shared internal voltage reference.



LOG114 functional block diagram.

Design Considerations

Output scaling—amplifier output is 0.32V, 0.5V or 1.0V per decade and is the equivalent of the gain setting in a voltage input amp.

Quiescent current—lowest in LOG101 and LOG104.

Conformity error—measured with 1nA to 1mA input current converted to 5V output. More than 16 bits of dynamic range are achievable.

Auxiliary op amps—some log amps have additional uncommitted op amps that can be used to offset and scale the output signal to suit application requirements.

Technical Information

Log amplifiers provide a very wide dynamic range (up to 160dB), extremely good DC accuracy and excellent performance over the full temperature range.

LOG114 Key Features

- Dynamic range: 8 decades (160dB)
- High-speed: 5MHz, 1μs rise/fall
- Precision: conformity error
- Single supply: 5V to 10V
- Integrated 2.5V reference
- 2 uncommitted op amps
- Packaging: QFN-16

Logarithmic Amplifiers Selection Guide

Device	Scale Factor (V/decade)	Input Current Range (nA) (min)	Input Current Range (mA) (max)	Conformity Error (Initial 5 Decades) (%) (max)	Conformity Error (Initial 5 Decades) (%/°C) (typ/temp)	Offset Voltage (Input Amplifiers) (mV) (max)	V_S (V) (min)	V_S (V) (max)	I_Q Per Ch. (mA) (max)	Reference Type	Auxiliary Op Amps	Package(s)	Price ¹
LOG101	1	0.1	3.5	0.2	0.0001	1.5	±4.5	±18	1.5	External	—	S0-8	\$6.95
LOG102	1	1	1	0.3	0.0002	1.5	±4.5	±18	2	External	2	S0-14	\$7.25
LOG104	0.5	0.1	3.5	0.2	0.0001	1.5	±4.5	±18	1.5	External	—	S0-8	\$6.95
LOG112	0.5	0.1	3.5	0.2	0.00001	1.5	±4.5	±18	1.75	2.5V Internal	1	S0-14	\$7.90
LOG2112	0.5	0.1	3.5	0.2	0.00001	1.5	±4.5	±18	1.75	2.5V Internal	1/Ch.	S0-16	\$11.35
LOG114	0.32	0.1	10	0.2	0.001	1.5	±2.5	±5.5	10	2.5V Internal	2	QFN-16	\$7.90
TL441*	0.32	0.01V	1V	—	—	—	±6	±8	5.75	—	—	DIP/SOP-16	\$3.24

¹Suggested resale price in U.S. dollars in quantities of 1,000. *80dB, 40MHz log amplifier IF, video applications. New products are listed in bold red. Preview products are listed in bold blue.

Integrating Amplifiers



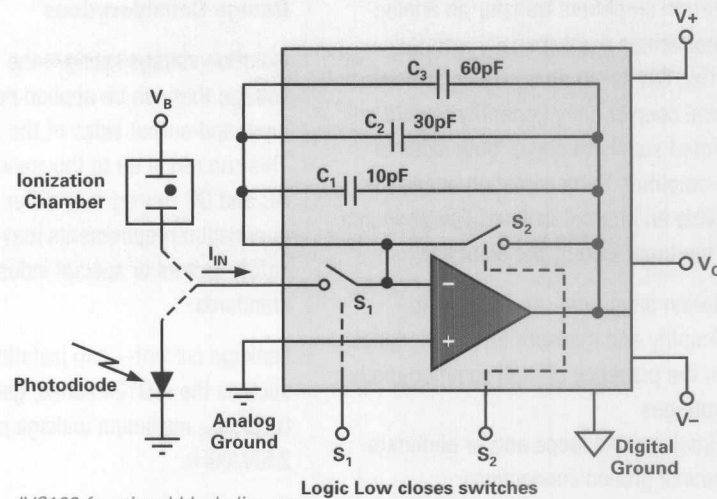
Integrating amplifiers provide a precision, lower noise alternative to conventional transimpedance op amp circuits which require a very high value feedback resistor. Designed to measure input currents over an extremely wide dynamic range, integrating amplifiers incorporate a FET op amp, integrating capacitors, and low-leakage FET switches. Integrating low-level input current for a user-defined period, the resulting voltage is stored on the integrating capacitor, held for accurate measurement and then reset. Input leakage of the IVC102 is only 750fA. It can also measure bipolar input currents.

The ACF2101 two-channel integrator offers extremely low bias current, low noise, an extremely wide dynamic range and excellent channel isolation. Included on each of the two integrators are precision 100pF integration capacitors, hold and reset switches and output multiplexers. As a complete circuit on a chip, leakage current and noise pickup errors are eliminated. An output capacitor can be used in addition to (or instead of) the internal capacitor depending on design requirements.

Design Considerations

Supply voltage—while single-supply operation is feasible, bipolar-supply operation is most common and will offer the best performance in terms of precision and dynamic range.

Number of channels—IVC102 offers a single integrator, while the ACF2101 is a dual.



IVC102 functional block diagram.

Integration direction—either into or out of the device. IVC102 is a bipolar input current integrator and will integrate both positive and negative signals. ACF2101 is a unipolar current integrator, with the output voltage integrating negatively.

Input bias (leakage) current—often sets a lower limit to the minimum detectable signal input current. Leakage can be subtracted from measurements to achieve extremely low-level current detection (<10fA). Circuit board leakage currents can also degrade the minimum detectable signal.

Sampling rate and dynamic range—the switched integrator is a sampled system controlled by the sampling frequency (f_s), which is usually dominated by the integration time. Input signals above the Nyquist frequency ($f_s/2$) create errors by being aliased into the sampling frequency bandwidth.

Technical Information

Although these devices use relatively slow op amps, they may be used to measure very fast current pulses. Photodiode or sensor capacitance can store a pulse charge temporarily, the charge is then slowly integrated during the next cycle.

See the OPT101 data sheet for monolithic photodiode and transimpedance amplifier. The OPT101 converts light directly into a voltage output, with low leakage current errors, minimal noise pick-up and low gain peaking due to stray capacitance.

Integrating Amplifiers Selection Guide

Device	Description	Input Bias Current (fA)	Switching Time (μ s)	Useful Sampling Rate (kHz)	Input Current Range (μ A)	Package(s)	Price ¹
IVC102	Precision, Low Noise, Bipolar Input Current	100	100	10	0.01 to 100	S0-14	\$4.55
ACF2101	Dual, Unipolar	100	200	10	0.01 to 100	S0-24	\$15.55
Monolithic Photodiode and Transimpedance Amplifier							
OPT101	Monolithic Photodiode with Built-In Transimpedance Amplifier	165	—	—	—	DIP, SIP	\$2.75

¹Suggested resale price in U.S. dollars in quantities of 1,000.



Isolation Amplifiers

Isolation amplifiers transfer an analog signal across a galvanically isolated barrier. Similar to an optically isolated digital coupler, they generally require an isolated supply to power both sides of the amplifier. Some isolation amplifiers provide an internal isolated power source for the input side of the amplifier.

Isolation amplifiers can be used to:

- Amplify and measure low-level signals in the presence of high common-mode voltages
- Break ground loops and/or eliminate source ground connections
- Provide an interface between a patient and medical monitoring equipment
- Provide isolation protection to electronic instruments and equipment

Design Considerations

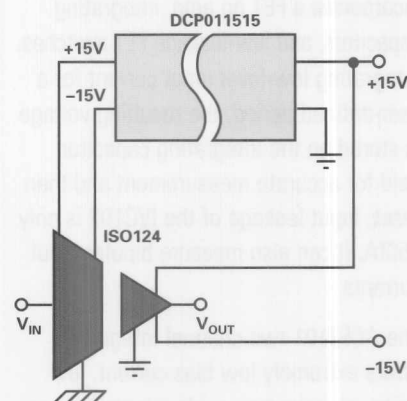
Isolation voltage rating—the maximum voltage that can be applied between the input and output sides of the amplifier. This can range up to thousands of volts. AC and DC ratings may differ and application requirements may dictate safety factors or special industry standards.

Leakage current—cap isolation amps, such as the ISO124 series, generally have $0.5\mu\text{A}_{\text{RMS}}$ maximum leakage current at 240V/60Hz.

Technical Information

Capacitive coupling transmits a differential pulse-coded representation of the analog input across two matched capacitors. The output section reconstructs the analog signal.

Wide barrier pin spacing and internal insulation allow for high isolation voltage ratings. Reliability is assured by 100% barrier breakdown testing that conforms to UL1244 test methods. Low barrier capacitance minimizes AC leakage currents.



ISO124 interface to DC/DC converter.

Isolation Amplifiers Selection Guide

Device	Description	Isolation Voltage Cont Peak (DC) (V)	Isolation Voltage Pulse/ Test Peak (V)	Isolation Mode Rejection DC (dB) (typ)	Gain Nonlinearity (%) (max)	Input Offset Voltage Drift ($\pm\mu\text{V}/^\circ\text{C}$) (max)	Small-Signal Bandwidth (kHz) (typ)	Package(s)	Price ¹
ISO122	1500V _{RMS} Isolation, Buffer	2121	2400	160	0.02	200	50	DIP-16, SOIC-28	\$9.40
ISO124	1500V _{RMS} Isolation, Buffer	2121	2400	140	0.01	—	50	DIP-16, SOIC-28	\$7.20
Digital Couplers									
ISO150	Dual, Bi-Directional Digital Coupler	1500	2400	—	—	—	—	DIP-12, SO-12	\$8.10

¹Suggested resale price in U.S. dollars in quantities of 1,000.

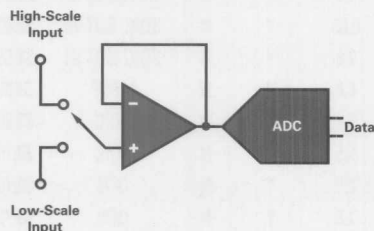
Amplifiers for Driving Analog-to-Digital Converters

Data acquisition systems generally require an amplifier preceding the ADCs to buffer the input signal. Most modern ADCs possess complex input characteristics due to the capacitive charging and switching that occurs during sampling and conversion. This behavior causes transient currents on the ADC's input that can disturb or distort a precision analog input signal. The input amplifier serves to provide a stable, accurate signal in the presence of these current transients. It can also provide gain (or attenuation), level shifting, filtering and other signal conditioning functions.

Selecting the input op amp requires attention to many considerations. DC accuracy may narrow the possible choices of an amplifier. The amplifier must have sufficiently low offset voltage, offset voltage drift, input bias current, noise, and so forth, to meet the required accuracy performance. It is often the dynamic performance characteristics, however, that prove most troublesome in the selection process. The amplifier must preserve the required dynamic signal characteristics.

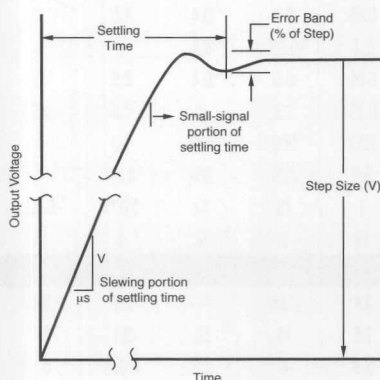
Design Considerations

Time domain issues—some applications demand that the amplifier respond accurately to full-scale changes in input voltage. For example, a multiplexed-input system may have input voltages equal to full-scale extremes on two adjacent inputs. The amplifier and ADC must respond to this sudden full-scale change in one sampling period.



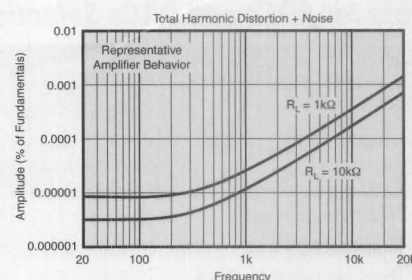
Multiplexed data acquisition systems require excellent dynamic behavior from op amps.

Settling time—an all-encompassing specification used to describe the ability of an amplifier to respond to a large change in input voltage. The settling time includes the large-signal period determined by slew rate and the small-signal settling period determined primarily by the bandwidth of the amplifier. Slewing time varies with the step size. Though generally specified for a specific step size, the settling time for other step sizes can be inferred from the slewing portion of the step.



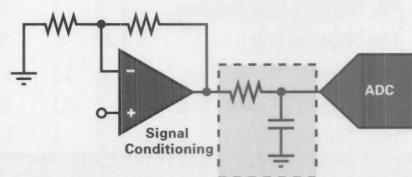
The small-signal portion of the settling waveform is affected by the gain of the input amplifier. If the amplifier is placed in a higher gain, system bandwidth is reduced, proportionally increasing the small-signal portion of the settling waveform.

Frequency domain performance—many ADCs are used to digitize dynamic waveforms such as audio. Rapid full-scale signal steps are rarely, if ever, encountered in these systems. For this reason, such systems generally specify spectral purity of the digitized signal. The amplifier must support this application with the required distortion performance. Many amplifiers specify THD+N (total harmonic distortion + noise). Other measures are also used. All these measures are made by applying a pure sine wave (or combination of sine waves) and measuring the spectral content in the amplifier's output that are not present in its input signal.



Technical Information

The input amplifier is generally connected to the ADC through an R-C network. Though often called a filter, this network actually serves as a "flywheel" in the presence of the current pulses created by the ADC's input circuitry. The circuit values of this circuit depend on both the amplifier and the ADC characteristics and often must be optimized for a particular application. The optimum capacitor value is generally in the range of 10 to 50 times the input capacitance of the ADC. The resistor is chosen to meet the speed or bandwidth requirement of the application.



"Flywheel" conditioning network.

The op amps shown in the following table are among the most likely choices for the indicated conversion speeds and ADC architectures. Depending on specific application requirements, other amplifiers may provide improved performance.

For a complete list of op amps, visit: amplifier.ti.com



Amplifiers for Driving Analog-to-Digital Converters

Amplifiers for ADCs and DACs Selection Guide

Device	Description	Ch.	V _S (V) (min)	V _S (V) (max)	I _Q Per Ch. (mA) (max)	GBW (MHz) (typ)	Slew Rate (V/μs) (typ)	V _{OS} (25°C) (mV) (max)	Offset Drift (μV/°C) (typ)	I _B (pA) (max)	V _N at 1kHz (nV/√Hz) (typ)	Single Supply	Rail- to- Rail	Package(s)	Price ¹
For Use with Medium-Speed SAR (<250kSPS)															
OPA656	Wideband, FET-Input	1	7	12.6	14	230	290	1.8	12	20μA	7	Y	N	SOIC, SOT-23	\$3.35
OPA350	Precision ADC Driver	1, 2, 4	2.7	5.5	7.5	38	22	0.5	4	10	5	Y	I/O	PDIP, MSOP	\$1.30
OPA228	Precision, Low Noise, G ≥ 5	1, 2, 4	5	36	3.8	33	10	0.075	0.1	10000	3	N	N	PDIP, SOIC	\$1.10
OPA627	Ultra-Low THD+N, Wide BW	1	9	36	7.5	16	55	0.1	0.4	5	5.2	N	N	PDIP, SOIC	\$12.25
TLE2027	Precision, Low Noise	1	8	38	5.3	13	2.8	0.1	0.4	90000	2.5	N	N	SOIC	\$0.90
OPA363	1.8V, High CMRR, SHDN	1, 2	1.8	5.5	0.75	7	5	0.5	2	10	17	Y	I/O	SOT23, MSOP	\$0.60
OPA340	CMOS, 0.0007% THD+N	1, 2, 4	2.7	5.5	0.95	5.5	6	0.5	2.5	10	25	Y	I/O	MSOP, SOT23	\$0.80
INA331	High Bandwidth, Single Supply	1, 2	2.7	5.5	0.5	5	5	0.5	5	10	46	Y	Out	MSOP	\$1.10
INA152	Diff Amp, 20mV Swing to Rail	1	2.7	20	0.65	0.8	0.4	1.5	3	—	87	Y	Out	MSOP	\$1.20
INA155	Medium Speed, Precision INA	1	2.7	5.5	2.1	0.55	6.5	1	5	10	40	Y	Out	MSOP	\$1.10
INA321	μPower Inst. Amp	1, 2	2.7	5.5	0.06	0.5	0.4	0.5	7	10	100	Y	Out	MSOP	\$1.10
INA128	High Precision, 120dB CMRR	1	4.5	36	0.75	1.3	4	0.5	0.2	5000	8	N	N	PDIP, SOIC	\$3.05
OPA842	Low Distortion, VFB	1	5	12.6	20.2	200	400	1.2	4	35	2.6	Y	N	SOIC, SOT-23	\$1.55
OPA820	Wideband, Low Noise, VFB	1	5	12.6	5.8	280	240	0.75	4	9μA	2.5	Y	N	SOIC, SOT-23	\$0.90
OPA381	Highest Precision High Speed Amp	1, 2	2.7	5.5	1	18	12	0.025	0.03	50	10	Y	Out	DFN, MSOP	\$1.45
LOG114	Fastest Precision Log Amp	1	4.5	11	15	5	5	4	15	5	500	Y	N	QFN-16	\$7.90
For Use with High-Resolution Delta-Sigma (ΔΣ)															
INA326	Auto-Zero INA, 110dB CMRR	1	2.5	5.5	3.4	1kHz	—	0.1	0.4	2000	33	Y	I/O	MSOP	\$1.80
OPA627	Ultra-Low THD+N, DiFET	1	9	36	7.5	16	55	0.1	0.4	5	5.2	N	N	PDIP, SOIC	\$12.25
OPA227	Ultra-Low Noise, Bipolar Input	1, 2, 4	5	36	3.8	8	2.3	0.075	0.1	10000	3	N	N	QFN, PDIP, SOIC	\$1.10
OPA335	5V, Precision, Auto-Zero Amp	1, 2	2.7	5.5	0.35	2	1.6	0.005	0.02	200	5.8	Y	Out	SOT23, MSOP	\$1.00
OPA735	12V, Precision, Auto-Zero Amp	1	2.7	13.2	0.75	1.6	1.5	0.005	0.05	200	—	Y	Out	SOT23, MSOP	\$1.25
OPA277	Low Offset and Drift	1, 2, 4	4	36	0.825	1	0.8	0.02	0.1	1000	8	N	N	QFN, SOIC, PDIP	\$0.85
OPA336	High Precision, μPower Amp	1, 2, 4	2.3	5.5	0.032	0.1	0.03	0.125	1.5	10	40	Y	Out	MSOP, PDIP	\$0.40
INA152	Single-Supply Difference Amp	1	2.7	20	0.65	0.800	0.4	1.5	3	—	87	Y	Out	MSOP	\$1.20
INA159	Level Translation Amp	1	1.8	5.5	1.4	1.5	15	0.5	2	—	30	Y	I/O	MSOP	\$1.50
For Use with High-Speed SAR (>250kSPS)															
THS4502/03	1 Differential In/Out, SHDN	1	4.5	15	23	370	2800	-4/+2	10	4.6μA	6.8	Y	N	MSOP	\$4.00
OPA355	CMOS, 2.7V Operation, SOT23	1, 2, 3	2.7	5.5	11	200	300	9	7	50	5.8	Y	Out	SOT23, SOIC	\$0.90
OPA2822	Dual Wideband, Low Noise, VFB	2	4	12.6	4.8	240	170	1.2	5	12μA	2	Y	N	SOIC, MSOP	\$1.45
OPA820	Wideband, Low Noise, VFB	1	5	12.6	5.75	280	240	0.75	4	17μA	2.5	Y	N	SOIC, SOT-23	\$0.90
OPA300	5V, SS, 16-Bit Settling Time	1	2.7	5.5	10	180	80	5	4	2	3	Y	Out	SOT23	\$1.25
OPA1632	Diff. I/O 0.00022% THD+N	1	5	32	17	180	50	3	5	6μA	1.3	N	N	MSOP, SOIC	\$1.75
THS4130/31	Differential In/Out, SHDN	1	5	30	15	135	52	2	4.5	6μA	1.3	Y	N	SOIC, MSOP	\$3.50
OPA842	Low Distortion, VFB	1	5	12.6	20.2	200	400	1.2	4	35	2.6	Y	N	SOIC, SOT-23	\$1.55
OPA727	CMOS, e-trim™, Low Noise	1, 2, 4	4	12	6.5	20	30	0.15	1.5	100	11	Y	N	MSOP, DFN, TSSOP	\$1.45
For Use with High-Speed Data Converters (Pipeline and Flash ADCs)															
OPA695	Ultra-Wideband CFB	1	5	12.6	12.3	—	4300	3	10	37μA	1.8	Y	N	SOT23, SOIC	\$1.35
OPA847	Low Noise, VFB with SHDN	1	7	12.6	18.1	3900	950	0.5	0.25	39μA	0.85	Y	N	SOIC, SOT-23	\$2.00
OPA842	Low Distortion, VFB	1	7	12.6	20.2	200	400	1.2	4	35μA	2.6	Y	N	SOIC, SOT-23	\$1.55
THS4502/03	Differential In/Out, SHDN	1	4.5	15	28	370	2800	-4/+2	10	4.6μA	6.8	Y	N	MSOP	\$4.00
OPA698	Wideband, VFB w/Limiting	1	5	12.6	15.5	250	1100	5	15	10μA	5.6	Y	N	SOIC	\$1.90
OPA2690	Dual VFB w/Disable Limiting	2	5	12.6	5.5	300	1800	4.5	12	10μA	5.5	Y	N	SOIC	\$2.15
THS4302	Wideband, Fixed Gain +5	1	3	5	37	2600	5500	4.25	20	10μA	2.8	Y	N	QFN	\$2.10
THS4509	Low Distortion, FDA	1	3	5	37.7	3000	6600	0.8	2.6	8μA	1.5	Y	N	QFN	\$3.75
OPA843	Low Distortion, G ≥ +3, VFB	1	7	12.6	20.2	800	1000	1.2	4	35μA	2.0	Y	N	SOIC, SOT23	\$1.60
OPA2613	Dual VFB, Low Noise	2	5	12.6	6	12.5	70	1	3.3	12μA	1.8	Y	N	SOIC	\$1.55
OPA2614	Dual VFB, Low Noise, G ≥ +2	2	5	12.6	6	250	165	1	3.3	12μA	1.8	Y	N	SOIC	\$1.55

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.

Delta-Sigma ($\Delta\Sigma$) ADCs

Delta-sigma converters are capable of very high resolution, and are ideal for converting signals over a very wide range of frequencies from DC to several megahertz. In a delta-sigma ADC, the input signal is oversampled by a modulator, then filtered and decimated by a digital filter producing a high-resolution data stream at a lower sampling rate.

The delta-sigma architecture approach allows resolution to be traded for speed and both to be traded for power. This nearly continuous relationship between data rate, resolution, and power consumption makes delta-sigma converters extraordinarily flexible. In many delta-sigma converters, this relationship is programmable, allowing a single device to handle multiple measurement requirements.

Because delta-sigma converters oversample their inputs, they can perform most anti-aliasing filtering in the digital domain. Modern VLSI design techniques have brought the cost of complex digital filters far below the cost of their analog equivalents. Formerly unusual functions, such as simultaneous 50Hz and 60Hz notch filtering, are now built into many delta-sigma ADCs.

Typical high-resolution applications for delta-sigma ADCs include audio, industrial process control, analytical and test instrumentation and medical instrumentation.

Recent innovations in ADC architectures have led to a new class of ADC architecture which uses both the pipeline and the oversampling principle. These very high speed converters push the data rates into the MSPS range while maintaining resolutions of bits and higher. These speeds enable a host of new wide bandwidth signal processing applications such as communications and medical imaging.

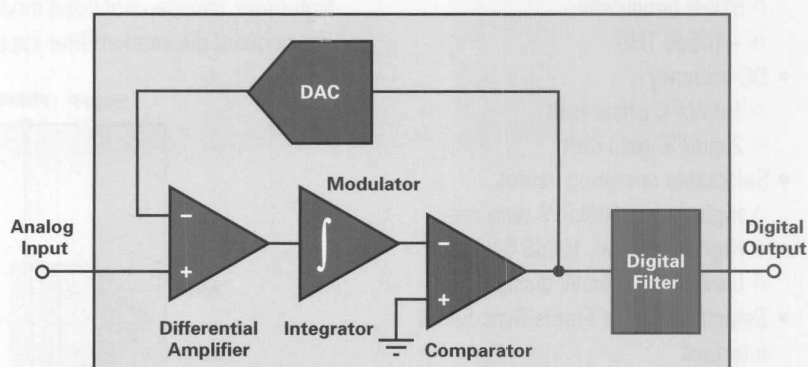
Almost all delta-sigma ADCs have inherently differential inputs. They measure the actual difference between two voltages, instead of the difference between one voltage and ground. The differential input structure of a delta-sigma makes it ideal for measuring differential sources such as bridge sensors and thermocouples. Frequently, no input amplifiers are required for these applications.

Delta-sigma converters work differently than SAR converters. A SAR takes a "snapshot" of an input voltage and analyzes it to determine the corresponding digital code. A delta-sigma measures the input signal for a certain period of time and outputs a digital code corresponding to the signal's average over that time. It is important to remember the way delta-sigma converters operate, particularly for designs incorporating multiplexing and synchronization.

It is very easy to synchronize delta-sigma converters together, so that they sample at the same time but it's more difficult to synchronize a delta-sigma converter to an external event. Delta-sigma converters are highly resistant to system clock jitter. The action of oversampling effectively averages the jitter, reducing its impact on noise.

Many delta-sigma converters include input buffers and programmable gain amplifiers (PGA). An input buffer increases the input impedance to allow direct connection to high source impedance signals. A PGA increases the converter's resolution when measuring small signals. Bridge sensors are an example of a signal source that can take advantage of the PGA within the converter.

Every ADC requires a reference, and for high-resolution converters, low-noise, low-drift references are critical. Most delta-sigma converters have differential reference inputs.



Delta-sigma ADCs consist of a delta-sigma modulator followed by a digital decimation filter. The modulator incorporates a comparator and integrator in a feedback loop with a DAC. The loop is synchronized by a clock.



Delta-Sigma ($\Delta\Sigma$) ADCs

24-Bit ADC with 4-Channel Differential Input ADS1222, ADS1224

Get samples, datasheets and app reports at: www.ti.com/sc/device/ADS1222 and www.ti.com/sc/device/ADS1224

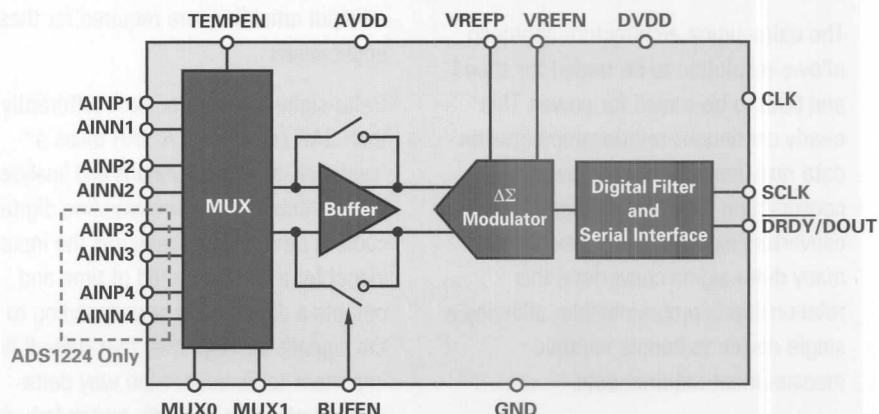
Key Features

- 240SPS data rate
- Input multiplexer with four differential channels (ADS1224)
- Pin-selectable input buffer
- $\pm 5V$ input range (differential)
- 0.0015% INL (max)
- Self-calibration
- Simple two-wire serial interface
- On-chip temperature sensor
- Low current consumption: 300 μA
- Sleep mode <1 μA

Applications

- Portable instrumentation
- Industrial process control
- Smart transmitters

The ADS1222 and ADS1224 are two and four channel precision, wide dynamic range ADCs with 24-bit resolution operating from a 2.7V to 5.5V supply. With a 2.5V reference, the full-scale differential input range is $\pm 5V$. The ADS1222 and ADS1224 are easy to use with a simple read-only serial interface and the onboard multiplexer, temperature sensor and input buffer controlled by dedicated I/O pins.



ADS1222 and ADS1224 functional block diagram.

24-Bit, Wide Bandwidth ADC ADS1271

Get samples, datasheets, EVMs and app reports at: www.ti.com/ads1271

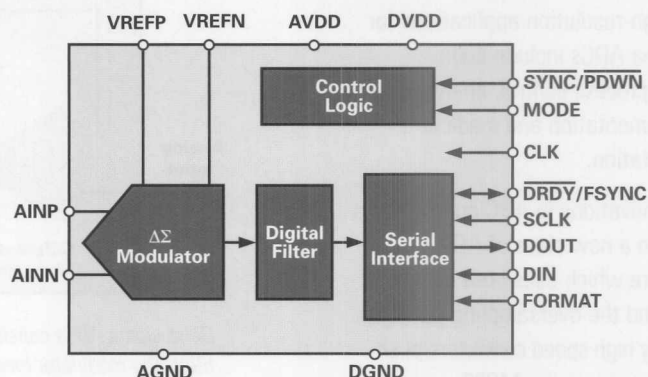
Key Features

- AC performance:
 - 51kHz bandwidth
 - -105dB THD
- DC accuracy:
 - 1.8 $\mu V/^{\circ}C$ offset drift
 - 2ppm/ $^{\circ}C$ gain drift
- Selectable operating modes:
 - High speed: 105kSPS data rate
 - High resolution: 109dB SNR
 - Low power: 35mW dissipation
- Selectable SPI or Frame Sync Serial interface
- Designed for multichannel systems:
 - Daisy-chainable serial interface
 - Easy synchronization
- Analog supply: 5V
- Digital supply: 1.8V to 3.3V

Applications

- Vibration/modal analysis
- Acoustics
- Dynamic strain gauges
- Pressure sensors
- Test and measurement

The ADS1271 is a 24-bit, delta-sigma ADC with a data rate up to 105kSPS. It offers the unique combination of excellent DC accuracy and outstanding AC performance. The high-order, chopper-stabilized modulator achieves very low drift with low in-band noise. The onboard decimation filter suppresses modulator and out-of-band noise.



Traditionally, industrial delta-sigma ADCs offering good drift performance used digital filters with large passband droop. As a result, they have limited signal bandwidth and are mostly suited for DC measurements. High-resolution ADCs in audio applications offer larger usable bandwidths, but the offset and drift specification are significantly weaker than their industrial counterparts. The ADS1271 combines these converter types, allowing high-precision industrial measurement with excellent DC and AC specifications ensured over an extended industrial temperature range.

Delta-Sigma ($\Delta\Sigma$) ADCs

Very Low-Noise, 24-Bit ADCs

ADS1255, ADS1256

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/ADS1255 and www.ti.com/sc/device/ADS1256

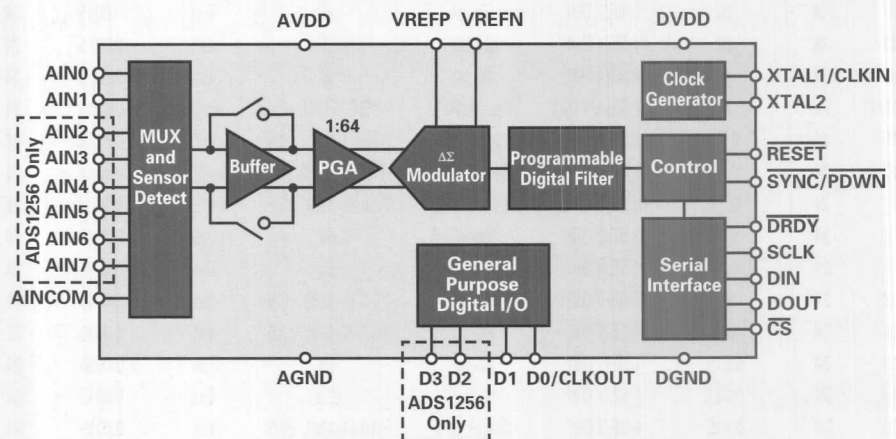
Key Features

- 24-bits, no missing codes
 - All data rates and PGA settings
- Up to 23-bits noise-free resolution
- $\pm 0.0010\%$ nonlinearity (max)
- Data output rates to 30kSPS
- Fast channel cycling
 - 18.6-bits noise-free (21.3 effective bits) at 1.45kHz
- One-shot conversions with single-cycle settling
- Input multiplexer (ADS1256)
 - 8 single-ended inputs
 - 4 differential inputs

Applications

- Medical equipment
- Scientific instrumentation
- Industrial process control
- Weigh scales
- Test and measurement

The ADS1255 and ADS1256 are two and eight channel extremely low-noise, 24-bit ADCs. Featuring up to 23-bits of noise-free resolution and data rates up to 30kSPS, they provide complete high-resolution measurement solutions for the most demanding applications.



ADS1255 and ADS1256 functional block diagram.

16-Bit, Very Wide Bandwidth ADCs

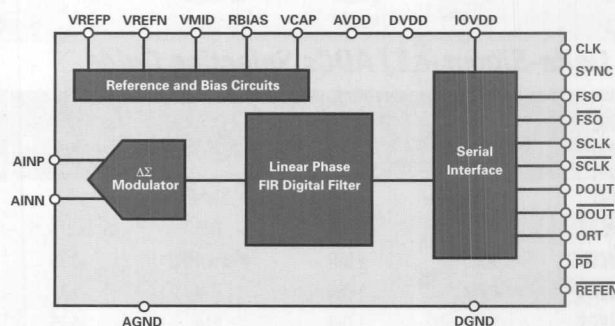
ADS1601, ADS1602

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/ADS1601 and www.ti.com/sc/device/ADS1602

Key Features

- High speed:
 - Data rate: 2.5MSPS (ADS1602)
 - Bandwidth: 1.23MHz (ADS1602)
- Outstanding performance:
 - SNR: 91dB at $f_{IN} = 100\text{kHz}$, -1dBFS
 - THD: -101dB at $f_{IN} = 100\text{kHz}$, -6dBFS
 - SFDR: 103dB at $f_{IN} = 100\text{kHz}$, -6dBFS
- Ease-of-use:
 - High-speed, 3-wire serial interface
 - Directly connects to TMS320™ DSPs
 - Simple pin-driven control—no on-chip registers to program
- Low power:
 - 330mW at 1.25MSPS (ADS1601)
 - 530mW at 2.5MSPS (ADS1602)
- Power-down mode
- Packaging: 7mm x 7mm TQFP

The ADS1601 and ADS1602 are pin-compatible, very wide bandwidth 16-bit ADCs. The ADS1601 operates at 1.25MSPS with a 615kHz bandwidth while dissipating only 330mW. The ADS1602 operates twice as fast at 2.5MSPS supporting a 1.23MHz bandwidth. Both offer outstanding performance with SNR over 90dB, THD less than -100dB and SFDR over 100dB. The onboard digital filter provides excellent out-of-band noise rejection and greatly reduces the anti-alias requirement. The ADS1601 and ADS1602 utilize an oversampling topology that reduces clock jitter sensitivity by a factor of four.



ADS1601 and ADS1602 functional block diagram.

Applications

- Sonar
- Vibration analysis
- Data acquisition

→ Delta-Sigma ($\Delta\Sigma$) ADCs

Delta-Sigma ($\Delta\Sigma$) ADCs Selection Guide

Device	Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Interface	Input Voltage (V)	V _{REF}	Linearity (%)	NMC (Bits)	Power (mW)	Package(s)	Price ¹
ADS1258	24	125	16 SE/8 Diff	Serial, SPI	±5	Ext	0.0015	24	40	QFN-48	\$8.95
ADS1271	24	105	1 Diff	Serial, SPI	±2.5	Ext	0.0015	24	35-100	TSSOP-16	\$5.90
ADS1252	24	41	1 SE/1 Diff	Serial	±5	Ext	0.0015	24	40	SOIC-8	\$5.60
ADS1255	24	30	2 SE/1 Diff	Serial, SPI	PGA (1-64), ±5V	Ext	0.001	24	35	SSOP-20	\$8.25
ADS1256	24	30	8 SE/4 Diff	Serial, SPI	PGA (1-64), ±5V	Ext	0.001	24	35	SSOP-28	\$8.95
ADS1251	24	20	1 SE/1 Diff	Serial	±5	Ext	0.0015	24	7.5	SOIC-8	\$5.60
ADS1253	24	20	4 SE/4 Diff	Serial	±5	Ext	0.0015	24	7.5	SSOP-16	\$6.70
ADS1254	24	20	4 SE/4 Diff	Serial	±5	Ext	0.0015	24	4	SSOP-20	\$6.70
ADS1210/11	24	16	1/4 SE/1/4 Diff	Serial, SPI	PGA (1-16), ±5	Int/Ext	0.0015	24	27.5	PDIP-18/24, SOIC-18/24, SSOP-28	\$10.25/\$10.90
ADS1216	24	0.78	8 SE/4 Diff	Serial, SPI	PGA (1-128), ±2.5	Int/Ext	0.0015	24	0.6	TQFP-48	\$5.00
ADS1217	24	0.78	8 SE/4 Diff	Serial, SPI	PGA (1-128), ±5	Int/Ext	0.0012	24	0.8	TQFP-48	\$5.00
ADS1218	24	0.78	8 SE/4 Diff	Serial, SPI	PGA (1-128), ±2.5	Int/Ext	0.0015	24	0.8	TQFP-48	\$5.50
ADS1222	24	0.24	2 SE/2 Diff	Serial	±5	Ext	0.0015	24	0.5	TSSOP-14	\$2.95
ADS1224	24	0.24	4 SE/4 Diff	Serial	±5	Ext	0.0015	24	0.5	TSSOP-20	\$3.25
ADS1232	24	0.8	2 SE/2 Diff	Serial	PGA (1-128), ±2.5	Ext	0.0015	24	3	TSSOP-24	\$3.90
ADS1234	24	0.8	4 SE/4 Diff	Serial	PGA (1-128), ±2.5	Ext	0.0015	24	3	TSSOP-28	\$4.50
ADS1244	24	0.015	1 SE/1 Diff	Serial	±5	Ext	0.0008	24	0.3	MSOP-10	\$2.95
ADS1245	24	0.015	1 SE/1 Diff	Serial	±2.5	Ext	0.0015	24	0.5	MSOP-10	\$3.10
ADS1240	24	0.015	4 SE/2 Diff	Serial, SPI	PGA (1-128), ±2.5	Ext	0.0015	24	0.6	SSOP-24	\$3.80
ADS1241	24	0.015	8 SE/4 Diff	Serial, SPI	PGA (1-128), ±2.5	Ext	0.0015	24	0.5	SSOP-28	\$4.20
ADS1242	24	0.015	4 SE/2 Diff	Serial, SPI	PGA (1-128), ±2.5	Ext	0.0015	24	0.6	TSSOP-16	\$3.60
ADS1243	24	0.015	8 SE/4 Diff	Serial, SPI	PGA (1-128), ±2.5	Ext	0.0015	24	0.6	TSSOP-20	\$3.95
ADS1212/13	22	6.25	1/4 SE/1/4 Diff	Serial, SPI	PGA (1-16), ±5	Int/Ext	0.0015	22	1.4	PDIP-18/24, SOIC-18/24, SSOP-28	\$7.70/\$9.00
ADS1250	20	25	1 SE/1 Diff	Serial, SPI	PGA (1-8), ±4	Ext	0.003	20	75	SOIC-16	\$6.95
ADS1100	16	0.128	1 SE/1 Diff	Serial, I ² C	PGA (1-8), V _{DD}	Ext	0.0125	16	0.3	SOT23-6	\$1.80
ADS1110	16	0.24	1 SE/1 Diff	Serial, I ² C	PGA (1-8), ±2.048	Int	0.01	16	0.7	SOT23-6	\$1.95
ADS1112	16	0.24	3 SE/2 Diff	Serial, I ² C	PGA (1-8), ±2.048	Int	0.01	16	0.7	MSOP-10, SON-10	\$2.65
TLC7135	14	3	1 SE/1 Diff	MUX BCD	±V _{REF}	Ext	0.005	4.5 Dig	5	PDIP-28, SOIC-28	\$1.95
ADS1000	12	0.128	1 SE/1 Diff	Serial, I ² C	PGA(1-8), V _{DD}	Ext	0.0125	12	0.3	SOT23-6	\$0.99
ADS1010	12	0.25	1 SE/1 Diff	Serial, I ² C	PGA(1-8), ±2.048	Int	0.01	12	0.7	SOT23-6	\$1.10
ADS1012	12	0.24	3 SE/1 Diff	Serial, I ² C	PGA(1-8), ±2.048	Int	0.01	12	0.7	MSOP-10, SON-10	\$1.45

MSC12xx For Intelligent Delta-Sigma ($\Delta\Sigma$) ADCs, refer to page 70

ADS12xx For Delta-Sigma ($\Delta\Sigma$) Modulators, refer to page 79

Delta-Sigma ($\Delta\Sigma$) ADCs for Measuring Low-Level Currents (Photodiodes)

Device	Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Interface	Input Voltage (V)	V _{REF}	Linearity (%)	NMC (Bits)	Power (mW)	Package(s)	Price ¹
DDC101	20	10	1	Serial	500pC	Ext	0.025	20	170	SOIC-24	\$23.00
DDC112	20	3	2	Serial	50-1000pC	Ext	0.025	20	80	SOIC-28, TQFP-32	\$12.10
DDC114	20	3	4	Serial	12-350pC	Ext	0.025	20	55	QFN-48	\$18.00
DDC118	20	3	8	Serial	12-350pC	Ext	0.025	20	110	QFN-48	\$32.00

Wide Bandwidth Delta-Sigma ($\Delta\Sigma$) ADCs Selection Guide

Device	Res. (Bits)	Sample Rate (kSPS)	Bandwidth (kHz)	Number of Input Channels	Interface	Input Voltage (V)	SNR (dB)	THD (dB)	Power (mW)	Package	Price ¹
ADS1271	24	105	51	1 Diff	Serial	±2.5	109	-105	35-100	TSSOP-16	\$5.90
ADS1625	18	1.25MSPS	615	1 Diff	P18	±3.75	93	-103	520	TQFP-64	\$37.60
ADS1626	18	1.25MSPS	615	1 Diff	P18 w/FIFO	±3.75	93	-103	520	TQFP-64	\$39.60
ADS1610	16	10MSPS	4900	1 Diff	P16	±3	84	-96	1000	TQFP-64	—
ADS1605	16	5MSPS	2450	1 Diff	P16	±3.75	88	-101	570	TQFP-64	\$32.05
ADS1606	16	5MSPS	2450	1 Diff	P16 w/FIFO	±3.75	88	-101	570	TQFP-64	\$33.75
ADS1602	16	2.5MSPS	1230	1 Diff	Serial	±3	91	-103	550	TQFP-48	\$23.00
ADS1601	16	1.25MSPS	615	1 Diff	Serial	±3	92	-105	350	TQFP-48	\$14.00

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in **bold red**. Preview products are listed in **bold blue**.

SAR ADCs



Successive-approximation register (SAR) converters are frequently the architecture of choice for medium-to-high-resolution applications with medium sampling rates. SAR ADCs range in resolution from 8 to 18 bits with speeds typically less than 10MSPS. They provide low power consumption and a small form factor.

A SAR converter operates on the same principle as a balance scale. On the scale, an unknown weight is placed on one side of the balance point, while known weights are placed on the other side and rejected or kept until the two sides are perfectly balanced. The unknown weight can then be measured by totaling up the kept, known weights. In the SAR converter, the input signal is the unknown weight, which is sampled and held. This voltage is then compared to successive known voltages, and the results are output by the converter. Unlike the weigh scale, conversion occurs very quickly through the use of charge redistribution techniques.

Because the SAR ADC samples the input signal and holds the sampled value until conversion is complete, this architecture does not make any assumptions about the nature of the input signal, and the signal therefore does not need to be continuous. This makes the SAR architecture ideal for applications where a multiplexer may be used prior to the converter, or for applications where the converter may only need to make a measurement once every few seconds, or for applications where a "fast" measurement is required. The conversion time remains the same in all cases, and has little sample-to-conversion latency compared to a pipeline or delta-sigma converter. SAR converters are ideal for real-time applications such as industrial control, motor control, power management, portable/battery-powered instruments, PDAs, test equipment and data/signal acquisition.

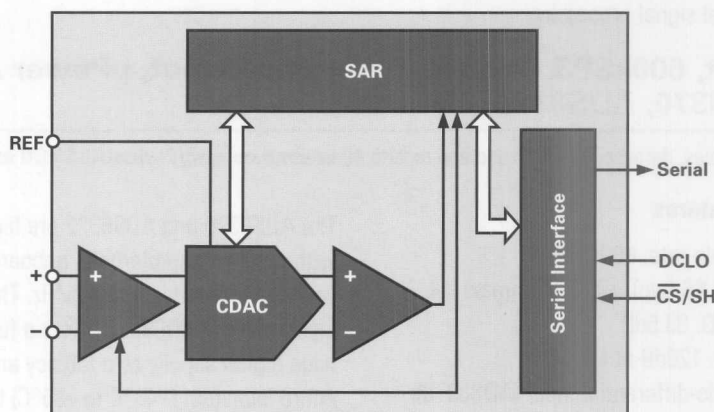
Technical Information

Modern SAR ADCs use a sample capacitor that is charged to the voltage of the input signal. Due to the ADC's input capacitance, input impedance, and external circuitry, a settling time will be required for the sample capacitor's voltage to match the measured input voltage.

Minimizing the external circuitry's source impedance is one way to minimize this settling time, assuring that the input signal is accurately acquired within the ADC's acquisition time. A more troublesome design constraint, however, is the dynamic load that the SAR ADC's input presents to the driving circuitry. The op amp driver to the ADC input must be able to handle this dynamic load and settle to the desired accuracy within the required acquisition time.

The SAR ADC's reference input circuitry presents a similar load to the reference voltage. While the reference voltage is supposed to be a very stable DC voltage, the dynamic load that the ADC's reference input presents makes achieving this goal somewhat difficult. Thus, buffer circuitry is required for the reference voltage, and the op amp used for this has similar requirements as that used for driving the ADC input; in fact, the requirements on the op amp may be even higher than for the input signal. Some SAR ADCs feature an internal reference buffer.

Buffering these inputs using op amps with a low, wideband output impedance is the best way to preserve accuracy with these converters.



In a SAR ADC, the bits are decided by a single high-speed, high-accuracy comparator bit by bit, from the MSB down to the LSB. This is done by comparing the analog input with a DAC whose output is updated by previously decided bits and successively approximates the analog input.



SAR ADCs

16-Bit, 250kSPS, Serial CMOS Sampling ADC ADS8509

Get samples, datasheets and app reports at: www.ti.com/sc/device/ADS8509

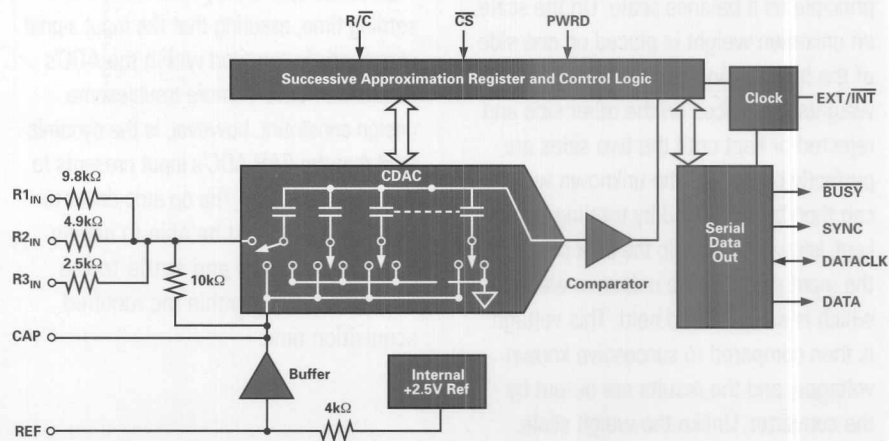
Key Features

- Sampling rate: 250kSPS
- Input ranges: 4V, 5V, 10V, $\pm 3.33V$, $\pm 5V$ and $\pm 10V$
- SINAD: 86dB with 20kHz input
- INL: $\pm 2.0LSB$
- DNL: 16-bits no missing codes
- Supply: 5V
- 75MHz ext. dataclk; 9MHz int.
- Power dissipation: 60mW typ at 250kSPS
- Pin compatible with ADS7809, ADS7808 and ADS8508
- Packaging: 20-lead SO and 28-lead SSOP

Applications

- Industrial process control
- Data acquisition systems
- Medical equipment
- Instrumentation
- Digital signal processing

The ADS8509 is a 16-bit, 250kSPS ADC complete with sample/hold, reference, clock and a serial data interface. Data can be output using the internal clock or can be synchronized to an external data clock. It can also provide an output synchronization pulse for ease of use with standard DSP processors. Calibrated resistors provide various input ranges including $\pm 10V$ and $0V-5V$, while the innovative design allows for operation from a single $+5V$ supply with power dissipation $<100mW$.



ADS8509 functional block diagram.

16-Bit, 600kSPS, Pseudo-Differential Input, μ Power ADCs ADS8370, ADS8372

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/ADS8370 and www.ti.com/sc/device/ADS8372

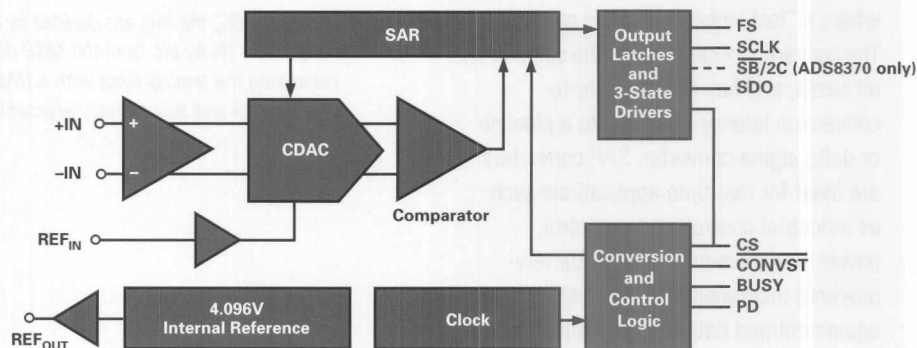
Key Features

- Sample rate: 600kSPS
- $\pm 0.4LSB$ (typ), $\pm 0.75LSB$ (max) INL
- SINAD: 93.5dB
- SFDR: 120dB at $f_1 = 1kHz$
- Pseudo-differential input (ADS8370): $0V$ to $4.2V$
- Pseudo-bipolar input (ADS8372): up to $\pm 4.2V$
- Low power:
 - 110mW at 600kHz
 - 15mW during Nap Mode
 - 10 μ W during Power Down
- Packaging: 28-lead 6 x 6 QFN

Applications

- Medical instruments
- Optical networking
- Transducer interface
- High-accuracy data acquisition systems
- Magnetometers

The ADS8370 and ADS8372 are high-performance, 16-bit, 600kSPS ADCs complete with inherent sample/hold, onboard reference and a high-speed, CMOS serial interface with clock speeds up to 40MHz. The ADS8370 offers unipolar (pseudo-differential) input, and the ADS8372 offers a fully differential, pseudo-bipolar input. Both offer a wide digital supply, zero latency and ensure 16-bit no missing code operation over the entire industrial ($-40^{\circ}C$ to $+85^{\circ}C$) temperature range.



ADS8370 and ADS8372 functional block diagram.

SAR ADCs



SAR ADCs Selection Guide

Device	Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Interface	Input Voltage (V)	V _{REF}	Linearity (%)	NMC	SINAD (dB)	Power (mW)	Package(s)	Price ¹
ADS8380	18	600	1 SE, 1 PDiff	Serial, SPI	V _{REF}	Int/Ext	0.0015	18	91	115	6X6 QFN-28	\$16.50
ADS8382	18	600	1 Diff	Serial, SPI	±V _{REF} (4.2V) at V _{REF} /2	Int/Ext	0.0012	18	96	115	6X6 QFN-28	\$16.95
ADS8381	18	580	1 SE, 1 PDiff	P8/P16/P18	V _{REF}	Ext	0.0015	16	93	115	TQFP-48	\$16.65
ADS8383	18	500	1 SE, 1 PDiff	P8/P16/P18	V _{REF}	Ext	0.0026	18	85	110	TQFP-48	\$15.75
ADS8411	16	2000	1 SE, 1 PDiff	P8/P16	V _{REF}	Int	0.0038	16	87	155	TQFP-48	\$22.00
ADS8412	16	2000	1 Diff	P8/P16	±V _{REF} (4.2V) at V _{REF} /2	Int	0.0038	16	90	155	TQFP-48	\$23.05
ADS8401	16	1250	1 SE, 1 PDiff	P8/P16	V _{REF}	Int	0.0053	16	85	155	TQFP-48	\$12.55
ADS8402	16	1250	1 Diff	P8/P16	±V _{REF} (4.2V) at V _{REF} /2	Int	0.0053	16	88	155	TQFP-48	\$13.15
ADS8405	16	1250	1 SE, 1 PDiff	P8/P16	V _{REF}	Int/Ext	0.003	16	85	155	TQFP-48	\$14.10
ADS8406	16	1250	1 Diff	P8/P16	±V _{REF} (4.2V) at V _{REF} /2	Int/Ext	0.003	16	90	155	TQFP-48	\$14.70
ADS8371	16	750	1 SE, 1 PDiff	P8/P16	V _{REF}	Ext	0.0023	16	87	130	TQFP-48	\$12.00
ADS8370	16	600	1 SE, 1 PDiff	Serial, SPI	V _{REF}	Int/Ext	0.0015	16	90	110	6X6 QFN-28	\$12.50
ADS8372	16	600	1 Diff	Serial, SPI	±V _{REF} (4.2V) at V _{REF} /2	Int/Ext	0.0012	16	94	110	6X6 QFN-28	\$13.00
ADS8322	16	500	1 PDiff	P8/P16	5	Int/Ext	0.009	15	83	85	TQFP-32	\$7.10
ADS8323	16	500	1 Diff	P8/P16	±2.5V at 2.5	Int/Ext	0.009	15	83	85	TQFP-32	\$7.10
ADS8361	16	500	2 x 2 Diff	Serial, SPI	±2.5V at ±2.5	Int/Ext	0.00375	14	83	150	SSOP-24	\$10.35
ADS8509	16	250	1 SE	Serial, SPI	+4, 10, ±3.3, 5, 10	Int/Ext	0.003	16	86	70	SOIC-20, SSOP-28	\$12.95
ADS8505	16	250	1 SE	P16	±10	Int/Ext	0.003	16	86	70	SOIC-28, SSOP-28	\$12.95
ADS8342	16	250	SE	P8/P16	±2.5	Ext	0.006	16	85	200	TQFP-48	\$11.30
ADS7811	16	250	1 SE	P16	±2.5	Int/Ext	0.006	15	87	200	SOIC-28	\$36.15
ADS7815	16	250	1 SE	P16	±2.5	Int/Ext	0.006	15	84	200	SOIC-28	\$21.30
ADS8364	16	250	1 x 6 Diff	P16	±2.5V at ±2.5	Int/Ext	0.0045	14	82.5	413	TQFP-64	\$18.10
TLC4541	16	200	1 SE	Serial, SPI	V _{REF}	Ext	0.0038	16	84.5	17.5	SOIC-8, VSSOP-8	\$6.85
TLC4545	16	200	1 PDiff	Serial, SPI	V _{REF}	Ext	0.0038	16	84.5	17.5	SOIC-8, VSSOP-8	\$6.85
ADS7805	16	100	1 SE	P8/P16	±10	Int/Ext	0.0045	16	86	81.5	PDIP-28, SOIC-28	\$21.80
ADS7809	16	100	1 SE	Serial, SPI	+4, 10, ±3.3, 5, 10	Int/Ext	0.0045	16	88	81.5	SOIC-20	\$21.80
ADS8320	16	100	1 PDiff	Serial, SPI	V _{REF}	Ext	0.012	15	84	1.95	VSSOP-8	\$5.15
ADS8321	16	100	1 Diff	Serial, SPI	±V _{REF} at +V _{REF}	Ext	0.012	15	84	5.5	VSSOP-8	\$5.15
ADS8325	16	100	1 PDiff	Serial, SPI	V _{REF}	Ext	0.006	16	91	2.25	VSSOP-8, QFN-8	\$5.90
ADS8341	16	100	4 SE/2 Diff	Serial, SPI	V _{REF}	Ext	0.006	15	86	3.6	SSOP-16	\$7.40
ADS8343	16	100	4 SE/2 Diff	Serial, SPI	±V _{REF} at V _{REF}	Ext	0.006	15	86	3.6	SSOP-16	\$7.45
ADS8344	16	100	8 SE/4 Diff	Serial, SPI	V _{REF}	Ext	0.006	15	86	3.6	SSOP-20	\$8.00
ADS8345	16	100	8 SE/4 Diff	Serial, SPI	±V _{REF} at V _{REF}	Ext	0.006	15	85	3.6	SSOP-20	\$8.00
ADS7807	16	40	1 SE	Serial, SPI/P8	4, 5, ±10	Int/Ext	0.0022	16	88	28	PDIP-28, SOIC-28	\$27.40
ADS7813	16	40	1 SE	Serial, SPI	+4, 10, ±3.3, 5, 10	Int/Ext	0.003	16	89	35	PDIP-16, SOIC-16	\$21.30
ADS7825	16	40	4 SE	Serial, SPI/P8	±10	Int/Ext	0.003	16	83	50	PDIP-28, SOIC-28	\$29.55
ADS7891	14	3000	1 SE	P8/P14	2.5	Int	0.009	14	78	90	TQFP-48	\$10.50
ADS7890	14	1250	1 SE	Serial, SPI	2.5	Int	0.009	14	78	90	TQFP-48	\$10.50
TLC3541	14	200	1 SE	Serial, SPI	V _{REF}	Ext	0.006	14	81.5	17.5	SOIC-8, VSSOP-8	\$5.00
TLC3544	14	200	4 SE/2 Diff	Serial, SPI	4	Int/Ext	0.006	14	81	20	SOIC-20, TSSOP-20	\$6.00
TLC3545	14	200	1 Diff	Serial, SPI	V _{REF}	Ext	0.006	14	81.5	17.5	SOIC-8, VSSOP-8	\$5.00
TLC3548	14	200	8 SE/4 Diff	Serial, SPI	4	Int/Ext	0.006	14	81	20	SOIC-24, TSSOP-24	\$6.40
TLC3574	14	200	4 SE	Serial, SPI	±10	Ext	0.006	14	79	29	SOIC-24, TSSOP-24	\$6.85
TLC3578	14	200	8 SE	Serial, SPI	±10	Ext	0.006	14	79	29	SOIC-24, TSSOP-24	\$8.65
ADS8324	14	50	1 Diff	Serial, SPI	±V _{REF} at +V _{REF}	Ext	0.012	14	78	2.5	VSSOP-8	\$4.15
ADS7871	14	40	8 SE/4 Diff	Serial, SPI	PGA (1, 2, 4, 8, 10, 16, 20)	Int	0.03	13	—	6	SSOP-28	\$5.00
ADS7881	12	4000	1 SE	P8/P12	2.5	Int	0.024	12	71.5	110	TQFP-48	\$7.35
ADS7869	12	1000	12 Diff	Serial, SPI/P12	±2.5 at ±2.5	Int/Ext	0.048	11	—	175	TQFP-100	\$14.60
ADS7886	12	1000	1 SE, 1 PDiff	Serial, SPI	V _{DD} (2.35V to 5.25V)	Ext (V _{DD})	0.036	12	70	17.5	SOT23-6, SC-70	\$2.25
ADS7810	12	800	1 SE	P12	±10	Int/Ext	0.018	12	71	225	SOIC-28	\$27.80
ADS7818	12	500	1 PDiff	Serial, SPI	5	Int	0.024	12	70	11	PDIP-8, VSSOP-8	\$2.50

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.



SAR ADCs

SAR ADCs Selection Guide (Continued)

Device	Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Interface	Input Voltage (V)	V _{REF}	Linearity (%)	NMC	SINAD (dB)	Power (mW)	Package(s)	Price ¹
ADS7834	12	500	1 PDiff	Serial, SPI	2.5	Int	0.024	12	70	11	VSSOP-8	\$2.45
ADS7835	12	500	1 Diff	Serial, SPI	±2.5	Int	0.024	12	72	17.5	VSSOP-8	\$2.75
ADS7852	12	500	8 SE	P12	5	Int/Ext	0.024	12	72	13	TQFP-32	\$3.40
ADS7861	12	500	2 x 2 Diff	Serial, SPI	±2.5 at +2.5	Int/Ext	0.024	12	70	25	SSOP-24	\$4.05
ADS7862	12	500	2 x 2 Diff	P12	±2.5 at +2.5	Int/Ext	0.024	12	71	25	TQFP-32	\$5.70
ADS7864	12	500	3 x 2 Diff	P12	±2.5 at +2.5	Int/Ext	0.024	12	71	52.5	TQFP-48	\$6.65
TLC2551	12	400	1 SE	Serial, SPI	V _{REF}	Ext	0.024	12	72	15	SOIC-8, VSSOP-8	\$3.95
TLC2552	12	400	2 SE	Serial, SPI	V _{REF}	Ext	0.024	12	72	15	SOIC-8, VSSOP-8	\$3.95
TLC2554	12	400	4 SE	Serial, SPI	4	Int/Ext	0.024	12	71	9.5	SOIC-16, TSSOP-16	\$5.30
TLC2555	12	400	1 PDiff	Serial, SPI	V _{REF}	Ext	0.024	12	72	15	SOIC-8, VSSOP-8	\$3.95
TLC2558	12	400	8 SE	Serial, SPI	4	Int/Ext	0.024	12	71	9.5	SOIC-20, TSSOP-20	\$5.30
ADS7800	12	333	1 SE	P8/P12	±5, 10	Int	0.012	12	72	135	CDIP SB-24, PDIP-24	\$30.50
ADS8508	12	250	1 SE	Serial, SPI	+4, 10, ±3.3, 5, 10	Int/Ext	0.011	12	73	70	SSOP-28, SOIC-28	\$8.90
ADS8504	12	250	1 SE	P8/P16	±10	Int/Ext	0.011	12	72	70	SSOP-28, SOIC-28	\$8.90
ADS7866	12	200	1 SE, 1 PDiff	Serial, SPI	V _{DD} (1.2V to 3.6V)	Ext	0.024	12	70	0.25	SOT23-6	\$2.15
ADS7816	12	200	1 PDiff	Serial, SPI	V _{REF}	Ext	0.024	12	72	1.9	PDIP-8, SOIC-8, VSSOP-8	\$1.95
ADS7817	12	200	1 Diff	Serial, SPI	±V _{REF} at +V _{REF}	Ext	0.024	12	71	2.3	SOIC-8, VSSOP-8	\$1.95
ADS7841	12	200	4 SE/2 Diff	Serial, SPI	V _{REF} , ±V _{REF} at V _{REF}	Ext	0.024	12	72	0.84	SSOP-16	\$2.50
ADS7842	12	200	4 SE	P12	V _{REF}	Ext	0.024	12	72	0.84	SSOP-28	\$3.10
ADS7844	12	200	8 SE/4 Diff	Serial, SPI	V _{REF} , ±V _{REF} at V _{REF}	Ext	0.024	12	72	0.84	SSOP-20	\$2.90
TLC2574	12	200	4 SE	Serial, SPI	±10	Ext	0.024	12	79	29	SOIC-20, TSSOP-20	\$5.30
TLC2578	12	200	8 SE	Serial, SPI	±10	Ext	0.024	12	79	29	SOIC-24, TSSOP-24	\$5.80
TLV2541	12	200	1 SE	Serial, SPI	V _{REF}	Ext	0.024	12	72	2.8	SOIC-8, VSSOP-8	\$3.85
TLV2542	12	200	2 SE	Serial, SPI	V _{REF}	Ext	0.024	12	72	2.8	SOIC-8, VSSOP-8	\$3.85
TLV2544	12	200	4 SE	Serial, SPI	+2, 4	Int/Ext	0.024	12	70	3.3	SOIC-16, TSSOP-16	\$4.20
TLV2545	12	200	1 PDiff	Serial, SPI	+5.5 (V _{REF} = V _{DD})	Ext	0.024	12	72	2.8	SOIC-8, VSSOP-8	\$3.85
TLV2548	12	200	8 SE	Serial, SPI	+2, 4	Int/Ext	0.024	12	70	3.3	SOIC-20, TSSOP-20	\$4.85
TLV2553	12	200	11 SE	Serial, SPI	V _{REF}	Ext	0.024	12	—	2.43	SOIC-20, TSSOP-20	\$3.40
TLV2556	12	200	11 SE	Serial, SPI	V _{REF}	Int/Ext	0.024	12	—	2.43	SOIC-20, TSSOP-20	\$3.55
ADS7829	12	125	1 PDiff	Serial, SPI	V _{REF}	Ext	0.018	12	71	0.6	QFN-8	\$1.50
AMC7823	12	200	8 SE I/O DAS	Serial, SPI	5	Int/Ext	0.024	12	74	100	QFN-40	\$13.50
AMC7820	12	100	8 DAS	Serial, SPI	5	Int	0.024	12	72 (typ)	40	TQFP-48	\$9.60
ADS7804	12	100	1 SE	P8/P16	±10	Int/Ext	0.011	12	72	81.5	PDIP-28, SOIC-28	\$14.05
ADS7808	12	100	1 SE	Serial, SPI	+4, 10, ±3.3, 5, 10	Int/Ext	0.011	12	73	81.5	SOIC-20	\$10.85
ADS7822	12	75	1 PDiff	Serial, SPI	V _{REF}	Ext	0.018	12	71	0.6	PDIP-8, SOIC-8, VSSOP-8	\$1.55
TLC2543	12	66	11 SE	Serial, SPI	V _{REF}	Ext	0.024	12	—	5	CDIP-20, PDIP-20, PLCC-20, SOIC-20, SSOP-20	\$4.45
TLV2543	12	66	11 SE	Serial, SPI	V _{REF}	Ext	0.024	12	—	3.3	PDIP-20, SOIC-20, SSOP-20	\$4.45
ADS7823	12	50	1 SE	Serial, I ² C	V _{REF}	Ext	0.024	12	71	0.75	VSSOP-8	\$2.85
ADS7828	12	50	8 SE/4 Diff	Serial, I ² C	V _{REF}	Int/Ext	0.024	12	71	0.675	TSSOP-16	\$3.35
ADS7870	12	50	8 SE	Serial, SPI	PGA(1, 2, 4, 8, 10, 16, 20)	Int	0.06	12	72	4.6	SSOP-28	\$4.15
ADS7806	12	40	1 SE	Serial, SPI/P8	+4, 5, ±10	Int/Ext	0.011	12	73	28	PDIP-28, SOIC-28	\$12.75
ADS7812	12	40	1 SE	Serial, SPI	+4, 10, ±3.3, 5, 10	Int/Ext	0.012	12	74	35	PDIP-16, SOIC-16	\$11.80
ADS7824	12	40	4 SE	Serial, SPI/P8	±10	Int/Ext	0.012	12	73	50	PDIP-28, SOIC-28	\$13.10
ADS1286	12	37	1 PDiff	Serial, SPI	V _{REF}	Ext	0.024	12	72	1	PDIP-8, SOIC-8	\$2.80
TLV1570	10	1250	8 SE	Serial, SPI	2V, V _{REF}	Int/Ext	0.1	10	60	9	SOIC-20, TSSOP-20	\$3.80
TLV1571	10	1250	1 SE	Serial, SPI	V _{REF}	Ext	0.1	10	60	12	SOIC-24, TSSOP-24	\$3.70

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SAR ADCs



SAR ADCs Selection Guide (Continued)

Device	Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Interface	Input Voltage (V)	V _{REF}	Linearity (%)	NMC	SINAD (dB)	Power (mW)	Package(s)	Price ¹
TLV1572	10	1250	1 SE	Serial, SPI	V _{REF}	Ext	0.1	10	60	8.1	SOIC-8	\$3.30
TLV1578	10	1250	8 SE	Serial, SPI	V _{REF}	Ext	0.1	10	60	12	TSSOP-32	\$3.85
ADS7887	10	1000	1 SE, 1 PDiff	Serial, SPI	V _{DD} (2.35V to 5.25V)	Ext (V _{DD})	0.073	10	61	17.5	SOT23-6, SC-70	\$1.65
TLC1514	10	400	4 SE/3 Diff	Serial, SPI	+5.5 (V _{REF} = V _{DD})	Int/Ext	0.012	10	60	10	SOIC-16, TSSOP-16	\$2.90
TLC1518	10	400	8 SE/7 Diff	Serial, SPI	+5.5 (V _{REF} = V _{DD})	Int/Ext	0.012	10	60	10	SOIC-20, TSSOP-20	\$3.45
ADS7867	10	200	1 SE, 1 PDiff	Serial, SPI	V _{DD} (1.2V to 3.6V)	Ext	0.05	10	61	0.25	SOT23-6	\$1.55
ADS7826	10	200	1 PDiff	Serial, SPI	V _{REF}	Ext	0.0048	10	62	0.6	QFN-8	\$1.25
TLV1504	10	200	4 SE	Serial, SPI	+2, 4	Int/Ext	0.05	10	60	3.3	SOIC-16, TSSOP-16	\$2.65
TLV1508	10	200	8 SE	Serial, SPI	+2, 4	Int/Ext	0.05	10	60	3.3	SOIC-20, TSSOP-20	\$3.15
TLC1550	10	164	1 SE	P10	V _{REF}	Ext	0.05	10	—	10	PLCC-28, SOIC-24	\$3.90
TLC1551	10	164	1 SE	P10	V _{REF}	Ext	0.1	10	—	10	PLCC-28, SOIC-24	\$3.35
TLV1544	10	85	4 SE	Serial, SPI	V _{REF}	Ext	0.1	10	—	1.05	SOIC-16, TSSOP-16	\$1.95
TLV1548	10	85	8 SE	Serial, SPI	V _{REF}	Ext	0.1	10	—	1.05	CDIP-20, LCCC-20, SSOP-20	\$2.30
TLC1542	10	38	11 SE	Serial, SPI	V _{REF}	Ext	0.05	10	—	4	CDIP-20, LCCC-20, PDIP-20, PLCC-20, SOIC-20	\$2.50
TLC1543	10	38	11 SE	Serial, SPI	V _{REF}	Ext	0.1	10	—	4	PLCC-20, SOIC-20, SSOP-280	\$1.90
TLC1549	10	38	1 SE	Serial, SPI	V _{REF}	Ext	0.1	10	—	4	PDIP-8, SOIC-8	\$1.71
TLV1543	10	38	11 SE	Serial, SPI	V _{REF}	Ext	0.1	10	—	2.64	CDIP-20, LCCC-20, PDIP-20, PLCC-20, SOIC-20, SSOP-20	\$2.15
TLV1549	10	38	1 SE	Serial, SPI	V _{REF}	Ext	0.1	10	—	1.32	PDIP-8, SOIC-8	\$1.85
TLC1541	10	32	11 SE	Serial, SPI	V _{REF}	Ext	0.1	10	—	6	PDIP-20, PLCC-20, SOIC-20	\$3.20
TLV571	8	1250	1 SE	P8	V _{REF}	Ext	0.5	8	49	12	SOIC-24, TSSOP-24	\$2.35
ADS7888	8	1000	1 SE, 1 PDiff	Serial, SPI	V _{DD} (2.35V to 5.25V)	Ext (V _{DD})	0.2	8	49	17.5	SOT23-6, SC-70	\$1.25
TLC0820A	8	392	1 SE	P8	V _{REF}	Ext	0.2	8	—	37.5	PLCC-20, SOIC-20, SSOP-20	\$1.90
ADS7827	8	250	1 PDiff	Serial, SPI	V _{REF}	Ext	0.2	8	48	0.6	QFN-8	\$1.00
ADS7868	8	200	1 SE, 1 PDiff	Serial, SPI	V _{DD} (1.2V to 3.6V)	Ext	0.1	8	50	0.25	SOT23-6	\$1.35
TLC545	8	76	19 SE	Serial, SPI	V _{REF}	Ext	0.2	8	—	6	PDIP-28, PLCC-28	\$3.10
ADS7830	8	75	8 SE/4 Diff	Serial, I ² C	V _{REF}	Int/Ext	0.19	8	50	0.675	TSSOP-16	\$1.40
TLV0831	8	49	1 SE	Serial, SPI	+3.6 (V _{REF} = V _{DD})	Ext	0.2	8	—	0.66	PDIP-8, SOIC-8	\$1.40
TLC548	8	45.5	1 SE	Serial, SPI	V _{REF}	Ext	0.2	8	—	9	PDIP-8, SOIC-8	\$1.20
TLV0832	8	44.7	2 SE/1 Diff	Serial, SPI	V _{REF}	Ext	0.2	8	—	5	PDIP-8, SOIC-8	\$1.40
TLV0834	8	41	4 SE/2 Diff	Serial, SPI	V _{REF}	Ext	0.2	8	—	0.66	PDIP-14, SOIC-14, TSSOP-14	\$1.45
TLC541	8	40	11 SE	Serial, SPI	V _{REF}	Ext	0.2	8	—	6	PDIP-20, PLCC-20, SOIC-20	\$1.50
TLC549	8	40	1 SE	Serial, SPI	V _{REF}	Ext	0.2	8	—	9	PDIP-8, SOIC-8	\$0.95
TLV0838	8	37.9	8 SE/4 Diff	Serial, SPI	V _{REF}	Ext	0.2	8	—	0.66	PDIP-20, SOIC-20, TSSOP-20	\$1.45
TLC0831	8	31	1 Diff	Serial, SPI	V _{REF}	Ext	0.2	8	—	3	PDIP-8, SOIC-8	\$1.40
TLC542	8	25	11 SE	Serial, SPI	V _{REF}	Ext	0.2	8	—	6	PDIP-20, PLCC-20, SOIC-20	\$1.50
TLC0832	8	22	2 SE/1 Diff	Serial, SPI	V _{REF}	Ext	0.2	8	—	12.5	PDIP-8, SOIC-8	\$1.40
TLC0834	8	20	4 SE/2 Diff	Serial, SPI	V _{REF}	Ext	0.2	8	—	3	PDIP-14, SOIC-14	\$1.45
TLC0838	8	20	8 SE/4 Diff	Serial, SPI	V _{REF}	Ext	0.2	8	—	3	PDIP-20, SOIC-20, TSSOP-20	\$1.45

¹ Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.



Pipeline ADCs

Analog-to-digital converters featuring sampling rates of 10s of MSPS are likely based on the pipeline architecture. The pipelined ADC consists of N cascaded stages. The concurrent operation of all pipeline stages makes this architecture suitable for achieving very high conversion rates. The stages themselves are essentially identical, lined up in an assembly line fashion and designed to convert only a portion of the analog sample. The digital output of each stage is combined to produce the parallel data output bits. A new digitized sample becomes available with every clock cycle. The internal combination process itself requires a digital delay, which is commonly referred to as the pipeline delay, or data latency. For most applications this is not a limitation since the delay, expressed in number of clock cycles, is a constant and can be accounted for.

One of the key architectural features of pipeline ADCs that allows high dynamic performances at high signal frequencies is the differential signal input. The differential input configuration results in the optimum dynamic range since it leads to smaller signal amplitude and a reduction in even-order harmonics. Almost all high-speed pipeline ADCs use a single-supply voltage, ranging from +5V down to +1.8V. Therefore, most require the analog input to operate with a common-mode voltage, which typically is at the mid-supply level. This common-mode or input bias requirement comes into consideration when defining the input interface circuitry that will drive the ADC. Switched capacitor inputs should also be considered.

Technical Information

Pipeline ADCs also employ the basic idea of moving charge samples, which represent the input voltage level at the particular sample incident, from one stage to the next. The differential pipeline structure is highly repetitive where each of the pipeline stages

consists of a sample-and-hold (S/H), a low-resolution ADC and DAC, and a summing circuit that includes an interstage amplifier to provide gain.

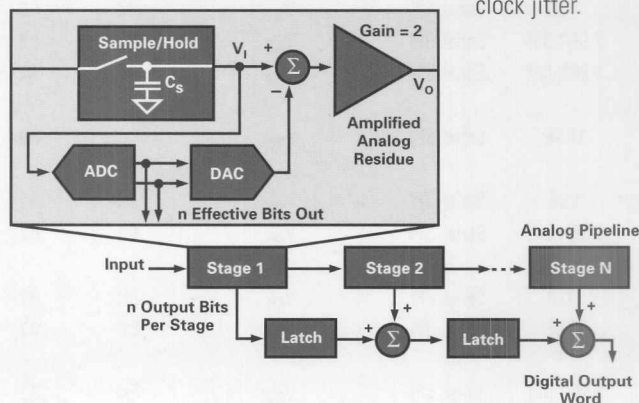
The analog signal is sampled with the first S/H circuit, which may also facilitate a single-ended to differential conversion. This S/H is one of the most critical blocks as it typically sets the performance limits of the converter. As the captured sample passes through the pipeline, the conversion is iterated by the stages that refine the conversion with increasing resolution as they pass the remainder signal from stage to stage. Each stage performs an analog-to-digital conversion, and a back-conversion to analog. The difference between the D/A output and the held input is the residue that is amplified and sent to the next stage where this process is repeated.

In order to properly design the interface circuit to the pipeline ADC, its switched-capacitor input structure needs to be considered. The input impedance of the pipeline converter represents a capacitive load to the driving source. Furthermore, it is dynamic since it is a function of the sampling rate ($1/f_s$). The internal switches generate small transient current pulses that may affect the settling behavior of the source. To reduce the effects of this switched-capacitor, input series resistors and a shunt capacitor are typically

recommended. This will also ensure stability and fast settling of the driving amplifier.

To select an appropriate interface circuit configuration, it is important to determine whether the application is time domain in nature (e.g. CCD-based imaging system) or a frequency domain application (e.g. communication system). Time domain applications usually have an input frequency bandwidth that includes DC. Frequency domain applications, on the other hand, are typically ac-coupled. The key converter specifications here are SFDR, SNR, aperture jitter and analog input bandwidth; the last two specifications particularly apply to undersampling applications. The optimum interface configuration will depend on whether the application calls for wide dynamic range (SFDR), or low noise (SNR), or both.

Critical to the performance of high-speed ADCs is the clock signal, since a variety of internal timing signals are derived from this clock. Pipeline ADCs may use both the rising and falling clock edge to trigger internal functions. For example, sampling occurs on the rising edge prompting this edge to have very low jitter. Clock jitter leads to aperture jitter, which can be the ultimate limitation in achieving good SNR performance. Particularly in undersampling applications, special consideration should be given to clock jitter.



Pipeline ADCs consist of consecutive stages, each containing a S/H, a low-resolution ADC and DAC, and a summing circuit that includes an interstage amplifier to provide gain.



12-Bit and 14-Bit at 80, 105 and 125MSPS High-Performance ADCs ADS5500 Family

Get samples, datasheets, EVMs and app reports at: www.ti.com/ads5500family

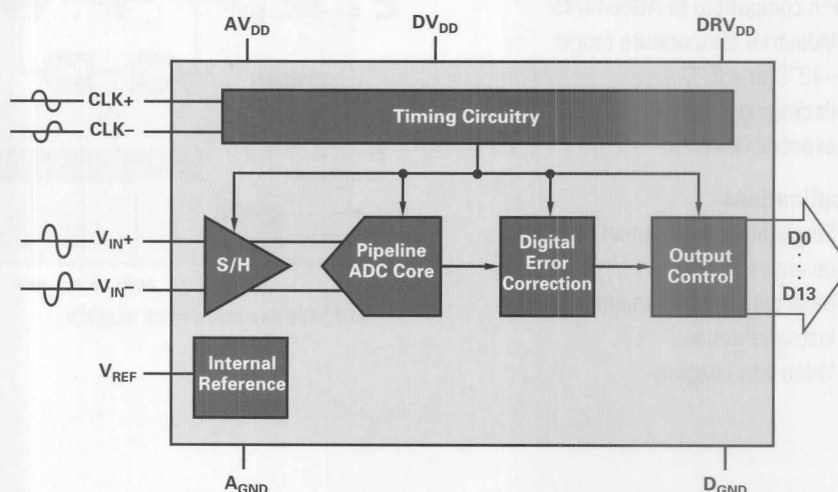
Key Features

- Single 12- and 14-bit, 80, 105, and 125MSPS ADCs
- Very low power dissipation ranging from 660mW – 780mW
- Pin-compatible family
- Single supply: 3.3V
- Analog input FSR: $2.3V_{P-P}$
- Data ready output clock
- Internal reference
- Ranging from 72 – 69dB SNR at 100MHz IF
- Ranging from 85 – 82dB SFDR at 100MHz IF
- 750MHz input bandwidth
- Supports high input frequencies for undersampling applications
- Package: 64-lead HTQFP

Applications

- Wireless communication
 - Communication receivers
 - Basestation infrastructure
- Test and measurement instrumentation
- Single and multichannel digital receivers
- Communication instrumentation
- Radar
- Video and imaging
- Medical equipment
- Guidance systems

The ADS5500 pin-compatible family provides an easy upgrade path that gives designers a range of resolution, speed and performance options tailored for individual application requirements. The 14-bit ADS5541 combines high performance (71dB SNR) at high speed (105MSPS) with half the power (739mW) of competitive devices, while the 14-bit ADS5542 is an economical 80MSPS device with low power (670mW) and excellent high-frequency performance. The ADS5520 (12-bit, 125MSPS) and the ADS5521 (12-bit, 105MSPS) deliver the highest signal accuracy and precision with an unmatched 69dB SNR at 100MHz IF. The ADS5522 (12-bit, 80MSPS) has an even higher SNR of 70dB. To enhance total system design, TI offers a portfolio of High-Performance Analog and DSP solutions complementary to the ADS5500 family.



ADS5500 family functional block diagram.



Pipeline ADCs

14-Bit, 80, 105MSPS ADCs ADS5424, ADS5423

Get datasheets and app reports at: www.ti.com/sc/device/ADS5424 and www.ti.com/sc/device/ADS5423

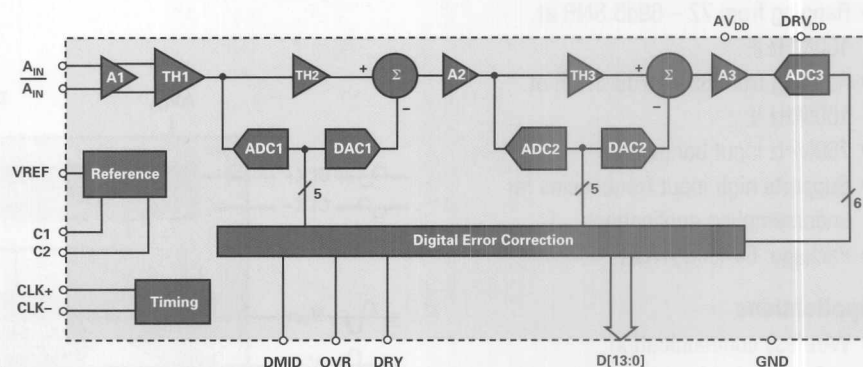
Key Features

- Resolution: 14-bit
- Sample rate: 105MSPS
- SNR: 74dBc at 105MSPS, 50MHz IF
- SFDR: 93dBc at 105MSPS, 50MHz IF
- Differential input range: 2.2Vpp
- Supply operation: 5V
- 3.3V CMOS compatible outputs
- Total power dissipation: 1.9W
- 2s complement output format
- On-chip input analog buffer, track and hold, and reference circuit
- Pin compatible to AD6644/45
- Industrial temperature range: -40°C to +85°C
- Packaging: 52-lead HTQFP with exposed heatsink

Applications

- Single and multichannel digital receivers
- Base station infrastructure
- Instrumentation
- Video and imaging

The ADS5424 is a 14-bit, 105MSPS ADC that operates from a 5V supply, while providing 3.3V CMOS compatible digital outputs. The ADS5424 input buffer isolates the internal switching of the on-chip Track and Hold (T&H) from distributing the signal source. An internal reference generator is also provided to further simplify the system design. The ADS5424 has outstanding low noise and linearity, over input frequency. With only a 2.2Vpp input range, the ADS5424 simplifies the design of multicarrier applications, where the carriers are selected on the digital domain.



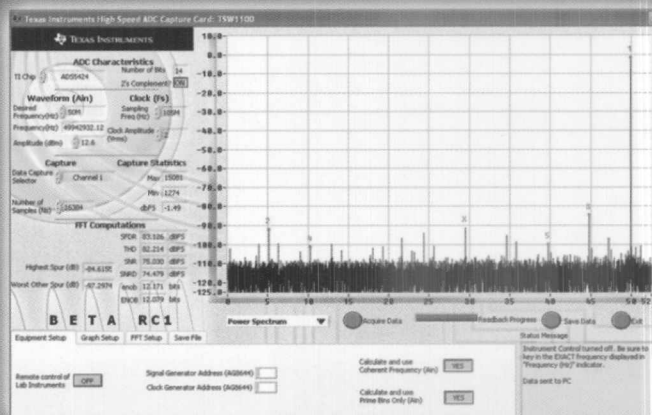
ADS5424 functional block diagram.

ADC Capture Card

Texas Instruments' new ADC Capture Card (TSW1100), allows for high-speed digital data capture from TI's high-speed, high-resolution analog-to-digital converters (ADCs). It comes complete with software, allowing the user to quickly evaluate TI's ADCs without the need for expensive logic analyzers and complex analysis routines.

- 1MB capture depth at 140MSPS
- Single channel or synchronous dual-channel operation/evaluation
- Operation off a single wall mount 12V DC power supply
- USB interface to PC
- Software that computes ADC performance

www.ti.com/tools



Pipeline ADCs



Pipeline ADCs Selection Guide

Device	Res. (Bits)	Sample Rate (MSPS)	Number of Input Channels	Input Voltage (V)	Analog Input Bandwidth (MHz)	DNL (\pm LSB)	INL (\pm LSB)	SNR (dB)	Supply Voltage (V)	Power (mW)	Package(s)	Price ¹
ADS5500	14	125	1 Diff	2	750	1.1	5	70.5	3, 3.6	780	HTQFP-64	\$95.00
ADS5424	14	105	1 Diff	2.2	570	-0.95, 1.5	1.5	74	4.75, 5.25	1900	HTQFP-52	\$56.00
ADS5541	14	105	1 Diff	2	750	-0.9, 1.1	5	72	3.0, 3.6	739	HTQFP-64	\$75.00
ADS5542	14	80	1 Diff	2	750	-0.9, 1.1	5	72.9	3.0, 3.6	674	HTQFP-64	\$25.55
ADS5423	14	80	1 Diff	2.2	570	-0.95, 1.5	1.5	74	4.75, 5.25	1850	HTQFP-52	\$40.00
ADS5553	14	65	2 Diff	2.3	750	1	4	74	3.0, 3.6	720	HTQFP-80	\$30.00
ADS5422	14	62	1 Diff	2 to 4	300	1	—	72	4.75, 5.25	1200	LQFP-64	\$30.45
ADS5421	14	40	1 Diff	2 to 4	300	1	—	75	4.75, 5.25	900	LQFP-64	\$20.15
ADS850	14	10	1 SE/1 Diff	2 to 4	300	1	5	76	4.7, 5.3	250	TQFP-48	\$16.80
THS1408	14	8	1 SE/1 Diff	1.5	140	1	5	72	3, 3.6	270	HTQFP-48, TQFP-48	\$14.85
THS1403	14	3	1 SE/1 Diff	1.5	140	1	5	72	3, 3.6	270	HTQFP-48, TQFP-48	\$11.05
THS14F03	14	3	1 SE/1 Diff	1.5	140	1	2.5	72	3, 3.6	270	TQFP-48	\$12.60
THS1401	14	1	1 SE/1 Diff	1.5	140	1	5	72	3, 3.6	270	HTQFP-48, TQFP-48	\$8.90
THS14F01	14	1	1 SE/1 Diff	1.5	140	1	2.5	72	3, 3.6	270	TQFP-48	\$9.65
ADS5520	12	125	1 Diff	2	750	0.5	1.5	69.7	3.0, 3.6	780	HTQFP-64	\$33.90
ADS5521	12	105	1 Diff	2	750	0.5	1.5	70	3.0, 3.6	736	HTQFP-64	\$29.90
ADS5522	12	80	1 Diff	2	750	0.5	1.5	69.7	3.0, 3.6	663	HTQFP-64	\$16.70
ADS5410	12	80	1 SE/1 Diff	2	1000	1	2	65	3, 3.6	360	TQFP-48	\$19.00
ADS809	12	80	1 SE/1 Diff	1 to 2	1000	1.7	6	63	4.75, 5.25	905	TQFP-48	\$24.95
ADS808	12	70	1 SE/1 Diff	1 to 2	1000	1.7	7	64	4.75, 5.25	720	TQFP-48	\$19.50
ADS5273	12	70	8 Diff	1.5	300	0.9	2	70.5	3, 3.6	1100	HTQFP-80	\$121.00
ADS5232	12	65	2 Diff	2.0	300	0.9	2	70.7	3, 3.6	340	TQFP-64	\$20.00
ADS5272	12	65	8 Diff	1.5	300	0.9	2	70.5	3, 3.6	984	HTQFP-80	\$65.00
ADS5221	12	65	1 SE/1 Diff	1 to 2	300	1	1.5	70	3.0, 3.6	285	TQFP-48, QFN-48	\$13.95
ADS5413	12	65	1 Diff	2	1000	1	2	68.5	3.0, 3.6	400	HTQFP-48	\$15.50
ADS5242	12	65	4 Diff	1.5	300	0.9	2	70.5	3.0, 3.6	683	TQFP-64	\$36.00
ADS807	12	53	1 SE/1 Diff	2 to 3	270	1	4	69	4.75, 5.25	335	SSOP-28	\$11.30
ADS5271	12	50	8 Diff	1.5	300	0.9	2	70.5	3.0, 3.6	957	HTQFP-80	\$50.00
ADS2807	12	50	2 SE/2 Diff	2 to 3	270	1	5	65	4.75, 5.25	720	TQFP-64	\$18.05
ADS5240	12	40	4 Diff	1.5	300	0.9	2	70.5	3.0, 3.6	607	TQFP-64	\$25.00
ADS5270	12	40	8 Diff	1.5	300	0.9	2	70.5	3.0, 3.6	907	HTQFP-80	\$45.00
ADS5220	12	40	1 SE/1 Diff	1 to 2	300	1	1.5	70	3.0, 3.6	195	TQFP-48, QFN-48	\$9.85
ADS800	12	40	1 SE/1 Diff	2	65	1	—	62	4.75, 5.25	390	SO-28, TSSOP-28	\$30.85
ADS2806	12	32	2 SE/2 Diff	2 to 3	270	1	4	66	4.75, 5.25	430	TQFP-64	\$14.10
THS1230	12	30	1 SE/1 Diff	1 to 2	180	1	2.5	67.7	3, 3.6	168	SOIC-28, TSSOP-28	\$10.50
ADS801	12	25	1 SE/1 Diff	1 to 2	65	1	—	64	4.75, 5.25	270	SO-28, SSOP-28	\$12.55
ADS805	12	20	1 SE/1 Diff	2	270	0.75	2	68	4.75, 5.25	300	SSOP-28	\$9.90
THS1215	12	15	1 SE/1 Diff	1 to 2	180	0.9	1.5	68.9	3, 3.6	148	SOIC-28, SSOP-28	\$9.85
ADS802	12	10	1 SE/1 Diff	2	65	1	2.75	66	4.75, 5.25	260	SO-28, SSOP-28	\$12.60
ADS804	12	10	1 SE/1 Diff	2	270	0.75	2	69	4.7, 5.3	180	SSOP-28	\$9.20
THS12082	12	8	2 SE/1 Diff	2.5	96	1	1.5	69	4.75, 5.25	186	TSSOP-32	\$8.40
THS1209	12	8	2 SE/1 Diff	2.5	98	1	1.5	69	4.75, 5.25	186	TSSOP-32	\$7.90
THS1206	12	6	4 SE/2 Diff	2.5	96	1	1.8	69	4.75, 5.25	186	TSSOP-32	\$7.80
THS1206-EP	12	6	4 SE/2 Diff	2.5	96	1	1.8	68	4.75, 5.25	186	TSSOP-32	\$16.01
THS1207	12	6	4 SE/2 Diff	2.5	96	1	1.5	69	4.75, 5.25	186	TSSOP-32	\$7.25
ADS803	12	5	1 SE/1 Diff	2	270	2	0.75	69	4.7, 5.3	115	SSOP-28	\$7.40
ADS5413-11	11	65	1 Diff	2	1000	0.75	1	65	3, 3.6	400	HTQFP-48	\$14.75
ADS828	10	75	1 SE/1 Diff	2	300	1	3	57	4.75, 5.25	340	SSOP-28	\$8.70
ADS5277	10	65	8 Diff	1.5	300	0.9	2	60.5	3, 3.6	950	HTQFP-80	\$32.00

¹ Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.



Pipeline ADCs

Pipeline ADCs Selection Guide (Continued)

Device	Res. (Bits)	Sample Rate (MSPS)	Number of Input Channels	Input Voltage (V)	Analog Input Bandwidth (MHz)	DNL (\pm LSB)	INL (\pm LSB)	SNR (dB)	Supply Voltage (V)	Power (mW)	Package(s)	Price ¹
ADS5102	10	65	1 Diff	1	950	1	2.5	57	1.65, 2	160	TQFP-48	\$7.10
ADS5122	10	65	8 Diff	1	22	1	2.5	59	1.65, 2.0	733	BGA-257	\$42.85
ADS823	10	60	1 SE/1 Diff	2	300	1	2	60	4.75, 5.25	295	SSOP-28	\$8.40
ADS826	10	60	1 SE/1 Diff	2	300	1	2	59	4.75, 5.25	295	SSOP-28	\$8.40
ADS5103	10	40	1 Diff	1	950	0.8	1.5	58	1.65, 2	105	TQFP-48	\$5.25
ADS5120	10	40	8 Diff	1	300	1	1.5	58	1.65, 2	794	BGA-257	\$36.15
ADS5121	10	40	8 Diff	1	28	1	1.5	60	1.65, 2.0	500	BGA-257	\$38.85
ADS5203	10	40	2 SE/2 Diff	1	300	1	1.5	60.5	3, 3.6	240	TQFP-48	\$9.65
ADS5204	10	40	2 SE/2 Diff	2	300	1	1.5	60.5	3, 3.6	275	TQFP-48	\$11.05
ADS821	10	40	1 SE/1 Diff	2	65	1	2	58	4.75, 5.25	390	SSOP-28, SO-28	\$13.05
ADS822	10	40	1 SE/1 Diff	2	300	1	2	60	4.75, 5.25	200	SSOP-28	\$5.25
ADS825	10	40	1 SE/1 Diff	2	300	1	2	60	4.75, 5.25	200	SSOP-28	\$5.25
THS1040	10	40	1 SE/1 Diff	2	900	0.9	1.5	57	3, 3.6	100	SOIC-28, TSSOP-28	\$5.10
THS1041	10	40	1 SE/1 Diff	2	900	1	1.5	57	3, 3.6	103	SOIC-28, TSSOP-28	\$5.45
THS1030	10	30	1 SE/1 Diff	2	150	1	2	49.4	3, 5.5	150	SOIC-28, TSSOP-28	\$3.75
THS1031	10	30	1 SE/1 Diff	2	150	1	2	49.3	3, 5.5	160	SOIC-28, TSSOP-28	\$4.10
ADS820	10	20	1 SE/1 Diff	2	65	1	2	60	4.75, 5.25	200	SSOP-28, SO-28	\$6.75
ADS900	10	20	1 SE/1 Diff	2	100	1	—	49	2.7, 3.7	54	SSOP-28	\$3.35
ADS901	10	20	1 SE/1 Diff	1	100	1	—	53	2.7, 3.7	49	SSOP-28	\$3.40
THS10082	10	8	2 SE/1 Diff	2.5	96	1	1	61	4.75, 5.25	186	TSSOP-32	\$3.70
THS1009	10	8	2 SE/1 Diff	+1.5, +3.5	96	1	1	61	4.75, 5.25	186	TSSOP-32	\$3.20
THS10064	10	6	4 SE/2 Diff	2.5	96	1	1	61	4.75, 5.25	186	TSSOP-32	\$4.15
THS1007	10	6	4 SE/2 Diff	+1.5, +3.5	96	1	1	61	4.75, 5.25	186	TSSOP-32	\$3.70
TLV1562	10	2	4 SE/2 Diff	3	120	1.5	1.5	58	2.7, 5.5	15	SOIC-28, TSSOP-28	\$4.15
ADS831	8	80	1 SE/1 Diff	1 or 2	300	1	2	49	4.75, 5.25	310	SSOP-20	\$3.15
TLV5580	8	80	1 SE	1 to 1.6	700	1.3	1.4	44	3, 3.6	213	SOIC-28, TSSOP-28	\$14.05
ADS830	8	60	1 SE/1 Diff	1 or 2	300	1	1.5	49.5	4.75, 5.25	215	SSOP-20	\$2.75
THS0842	8	40	2 SE/2 Diff	1.3	600	2	2.2	42.7	3, 3.6	320	TQFP-48	\$5.05
TLC5540	8	40	1 SE	2	75	1	1	44	4.75, 5.25	85	SOP-24, TSSOP-24	\$2.40
TLV5535	8	35	1 SE	1 to 1.6	600	1.3	2.4	46.5	3, 3.6	106	TSSOP-28	\$2.40
ADS930	8	30	1 SE/1 Diff	1	100	1	2.5	46	2.7, 5.25	168	SSOP-28	\$2.30
ADS931	8	30	1 SE	1 to 4	100	1	2.5	48	2.7, 5.5	154	SSOP-28	\$2.20
TLC5510	8	20	1 SE	2	14	0.75	1	46	4.75, 5.25	127.5	SOP-24	\$2.35
TLC5510A	8	20	1 SE	2	14	0.75	1	46	4.75, 5.25	150	SOP-24	\$2.35

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Delta-Sigma ($\Delta\Sigma$) DACs

Delta-sigma ($\Delta\Sigma$) DACs are the converse of delta-sigma ADCs with a digital modulator and analog filter. $\Delta\Sigma$ DACs include a serial interface, control registers, modulator, switched capacitor

filter and a clock for the modulator and filter. $\Delta\Sigma$ DACs have high resolution and low power making them ideal for closed-loop control in industrial control applications, high-resolution test and

measurement equipment, remote applications, battery-powered instruments and isolated systems.

 $\Delta\Sigma$ DACs Selection Guide

Device	Res. (Bits)	Settling Time (ms)	Number of Output DACs	Interface	Output (V)	V_{REF}	Linearity (%)	Monotonicity (Bits)	Power (mW)	Package	Price ¹
DAC1220	20	10	1	Serial, SPI	5	Ext	0.0015	20	2.5	SSOP-16	\$6.33
DAC1221	16	2	1	Serial, SPI	2.5	Ext	0.0015	16	1.2	SSOP-16	\$5.01

¹Suggested resale price in U.S. dollars in quantities of 1,000.

String and R-2R DACs

Resistor "String" and R-2R DACs consist of four major elements: logic circuitry; some type of resistor network means of switching either a reference voltage or current to the proper input terminals of the network as a function of the digital value of each digital input bit, and a reference voltage.

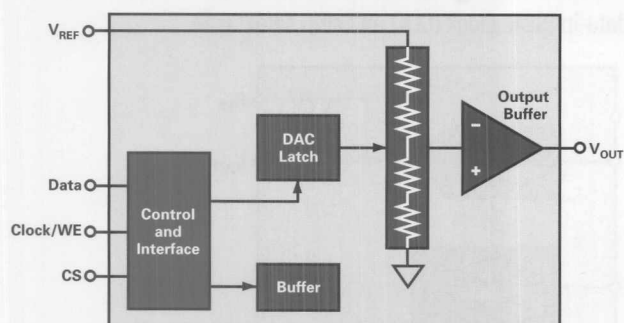
Technical Information

R-2R DACs — are used to achieve the best integral linearity performance. In an R-2R DAC a current is generated by a reference voltage, which flows through the R-2R resistor network based on the digital input, which divides the current

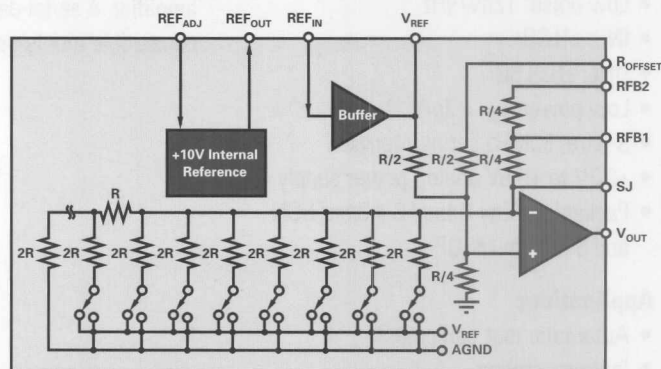
by two at each R-2R node. The advantage of a R-2R type DAC is that it relies on the matching of the R and 2R resistor segments and not the absolute value of the resistors thus allowing trim techniques to be used to adjust the integral linearity and differential linearity.

Voltage Segment DACs (String DACs) — are simply a string of resistors, each of value R. The code loaded into the DAC register determines at which node on the string the voltage is tapped off to be fed into the output amplifier by closing one of the switches connecting the string to the amplifier. The DAC is monotonic, because it is a string of resistors. In higher resolution

12- and 16-bit DACs, two resistor strings are used to minimize the number of switches in the design. In a two-resistor string configuration, the most significant bits drive a decoder tree, which selects the voltages from two adjacent taps of the first resistor string and applies them to the inputs of two buffers. These buffers then force these voltages across the endpoints of the second resistor string. The least significant data bits drive a second decoder tree, which selects the voltage at one of the switch outputs and directs it to the output buffer.



Voltage segment DAC.



Segmented R-2R DAC.



String and R-2R DACs

12-Bit, Quad, Ultra-low Glitch, Voltage Output DAC DAC7554

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/DAC7554

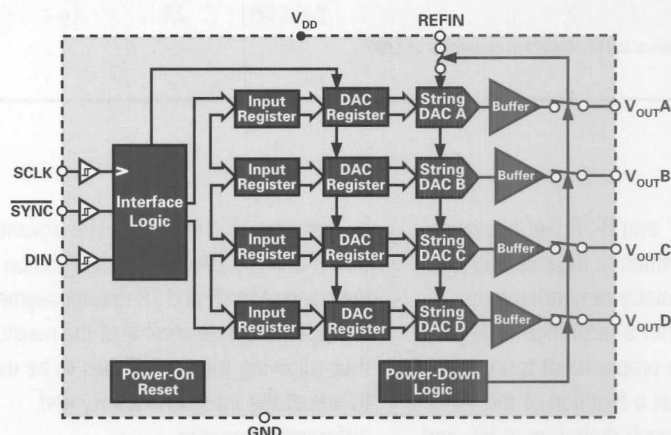
Key Features

- 2.7V to 5.5V single supply
- 12-bit linearity and monotonicity
- Rail-to-rail voltage output
- Settling time: 5 μ s (max)
- Ultra-low glitch energy: 0.1nVs
- Ultra-low crosstalk: -100 dB
- Low power: 880 μ A (max)
- Per-channel power down: 2 μ A (max)
- Power-on reset to zero scale
- SPI-compatible serial interface: up to 50MHz
- Specified temperature range: -40°C to $+105^{\circ}\text{C}$

Applications

- Portable battery-powered instruments
- Digital gain and offset adjustment
- Programmable voltage and current sources
- Programmable attenuators
- Industrial process control

The DAC7554 is a quad-channel, voltage-output DAC with exceptional linearity and monotonicity. Its proprietary architecture minimizes undesired transients such as code to code glitch and channel to channel crosstalk. The low-power DAC7554 operates from a single 2.7V to 5.5V supply. The DAC7554 output amplifiers can drive a 2k Ω , 200pF load rail-to-rail with 5 μ s settling time; the output range is set using an external voltage reference.



DAC7554 functional block diagram.

14-Bit, Serial Input, Multiplying DAC DAC8801, DAC8811

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/DAC8801 and www.ti.com/sc/device/DAC8811

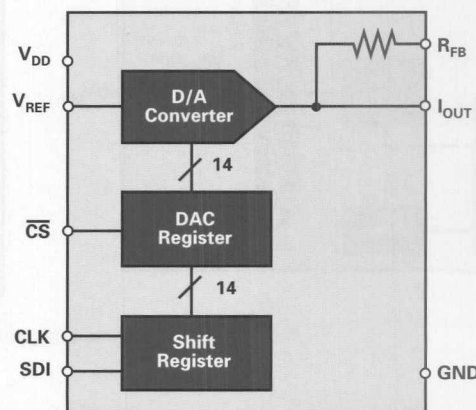
Key Features

- 16-bit monotonic (DAC8811), 14-bit monotonic (DAC8801)
- Settling time: 0.5 μ s
- Low noise: 12nV/ $\sqrt{\text{Hz}}$
- INL: ± 1 LSB
- DNL: ± 0.5 LSB
- Low power: $I_{DD} = 2\mu\text{A}$
- 3-wire, 50MHz serial interface
- +2.7V to +5.5V analog power supply
- Packaging: Tiny 8-lead 3 x 3mm SON and 3 x 5mm MSOP

Applications

- Automatic test equipment
- Instrumentation
- Digitally controlled calibration
- Industrial control PLCs

The DAC8801 is a 14-bit, serial input, multiplying DAC designed to operate from a single supply, 2.7V-5.5V. The applied external reference input voltage, V_{REF} , determines the full-scale output current. An internal feedback resistor, R_{FB} , provides temperature tracking for the full-scale output when combined with an external I-to-V precision amplifier. A serial-data interface offers high-speed, three-wire microcontroller-compatible inputs using data-in (SDI), clock (CLK) and chip select ($\overline{\text{CS}}$).



DAC8801 functional block diagram.

String and R-2R DACs

16-Bit, Ultra-Low Power, Voltage-Output DAC
DAC8830, DAC8831

Get samples, datasheets and app reports at: www.ti.com/sc/device/DAC8830 and www.ti.com/sc/device/DAC8831

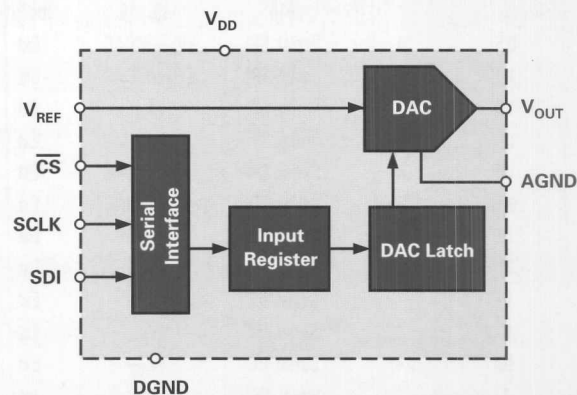
Key Features

- 16-bit resolution
- 2.7V to 5.5V single-supply operation
- Very low power: 15µW for 3V power
- High accuracy, INL: 1LSB
- Low glitch: 8nVs
- Low noise: 10nV/√Hz
- Fast settling: 1.0µs
- Fast SPI interface, up to 50MHz
- Reset to zero-code
- Schmitt-trigger inputs for direct optocoupler interface
- Industry-standard pin configuration

Applications

- Portable equipment
- Automatic test equipment
- Industrial process control
- Data acquisition systems
- Optical networking

The DAC8830 and DAC8831 are single, 16-bit serial-input, voltage-output DACs operating from a single 3V to 5V power supply. These converters provide excellent linearity (1LSB INL), low glitch, low noise, and fast settling time (1.0µs to 1/2 LSB of full-scale output) over the specified temperature range of -40°C to +85°C. The output is unbuffered, which reduces the power consumption and the error introduced by the buffer.



DAC8830 functional block diagram.

String and R-2R DACs Selection Guide

Device	Architecture	Res. (Bits)	Settling Time (µs)	Number of Output DACs	Interface	Output (V)	V _{REF}	Linearity (%)	Monotonic (Bits)	Power (mW) (typ)	Package(s)	Price ¹
DAC7654	R-2R	16	12	4	Serial, SPI	±2.5	Int	0.0015	16	18	LQFP-64	\$21.80
DAC7664	R-2R	16	12	4	P16	±2.5	Int	0.0015	16	18	LQFP-64	\$20.75
DAC7634	R-2R	16	10	4	Serial, SPI	+V _{REF} , ±V _{REF}	Ext	0.0015	15	7.5	SSOP-48	\$19.95
DAC7641	R-2R	16	10	1	P16	+V _{REF} , ±V _{REF}	Ext	0.0015	15	1.8	TQFP-32	\$6.30
DAC7642	R-2R	16	10	2	P16	+V _{REF} , ±V _{REF}	Ext	0.0015	15	2.5	LQFP-32	\$10.55
DAC7643	R-2R	16	10	2	P16	+V _{REF} , ±V _{REF}	Ext	0.0015	15	2.5	LQFP-32	\$10.55
DAC7644	R-2R	16	10	4	P16	+V _{REF} , ±V _{REF}	Ext	0.0015	15	7.5	SSOP-48	\$19.95
DAC7734	R-2R	16	10	4	Serial, SPI	+V _{REF} , ±V _{REF}	Ext	0.0015	16	50	SSOP-48	\$31.45
DAC712	R-2R	16	10	1	P16	±10	Int	0.003	15	525	SOIC-28	\$14.50
DAC714	R-2R	16	10	1	Serial, SPI	±10	Int	0.0015	16	525	SOIC-16	\$14.50
DAC715	R-2R	16	10	1	P16	+10	Int	0.003	16	525	SOIC-28	\$15.85
DAC716	R-2R	16	10	1	Serial, SPI	+10	Int	0.003	16	525	SOIC-16	\$15.85
DAC7631	R-2R	16	10	1	Serial, SPI	+V _{REF} , ±V _{REF}	Ext	0.0015	15	1.8	SSOP-20	\$5.85
DAC7632	R-2R	16	10	2	Serial, SPI	+V _{REF} , ±V _{REF}	Ext	0.0015	15	2.5	LQFP-32	\$10.45
DAC7744	R-2R	16	10	4	P16	+V _{REF} , ±V _{REF}	Ext	0.0015	16	50	SSOP-48	\$31.45
DAC8501	String	16	10	1	Serial, SPI	V _{REF} /MDAC	Ext	0.0987	16	0.72	VSSOP-8	\$3.00
DAC8531	String	16	10	1	Serial, SPI	+V _{REF}	Ext	0.0987	16	0.72	VSSOP-8, QFN 3 x 3	\$3.00
DAC8532	String	16	10	2	Serial, SPI	+V _{REF}	Ext	0.0987	16	1.35	VSSOP-8	\$5.35
DAC8544	String	16	8	4	Parallel	+V _{REF}	Ext	0.025	16	4.75	QFN 5 x 5	\$9.75
DAC8534	String	16	10	4	Serial, SPI	+V _{REF}	Ext	0.0987	16	2.7	TSSOP-16	\$9.75

¹Suggested resale price in U.S. dollars in quantities of 1,000.



String and R-2R DACs

String and R-2R DACs Selection Guide (Continued)

Device	Architecture	Res. (Bits)	Settling Time (μ s)	Number of Output DACs	Interface	Output (V)	V _{REF}	Linearity (%)	Monotonic (Bits)	Power (mW) (typ)	Package(s)	Price ¹
DAC8541	String	16	10	1	P16	+V _{REF}	Ext	0.096	16	0.72	TQFP-32	\$3.00
DAC8554	String	16	10	1	Serial, SPI	+V _{REF}	ext	0.0122	16	1	MSOP-8, SON-8	\$3.45
DAC8571	String	16	10	1	Serial, I ² C	+V _{REF}	Ext	0.0987	16	0.42	MSOP-8	\$2.95
DAC8574	String	16	10	4	Serial, I ² C	+V _{REF}	Ext	0.0987	16	2.7	TSSOP-16	\$10.25
DAC7731	R-2R	16	5	1	Serial, SPI	+10, \pm 10	Int/Ext	0.0015	16	100	SSOP-24	\$8.20
DAC7742	R-2R	16	5	1	P16	+10, \pm 10	Int/Ext	0.0015	16	100	LQFP-48	\$8.70
DAC7741	R-2R	16	5	1	P16	+10, \pm 10	Int/Ext	0.0015	16	100	LQFP-48	\$8.30
DAC8811	R-2R	16	0.5	1	Serial, SPI	\pm V _{REF} /MDAC	Ext	0.0015	16	0.025	MSOP-8, SON-8	\$8.50
DAC8814	R-2R	16	1.0	4	Serial, SPI	\pm V _{REF} /MDAC	Ext	0.0015	16	0.0275	SSOP-28	\$19.27
DAC8830	R-2R	16	1.0	1	Serial, SPI	+V _{REF}	Ext	0.0015	16	0.015	SOIC-8	\$7.95
DAC8831	R-2R	16	1.0	1	Serial, SPI	+V _{REF}	Ext	0.0015	16	0.015	SOIC-14	\$7.95
DAC8803	R-2R	14	1.0	4	Serial, SPI	\pm V _{REF} /MDAC	Ext	0.0061	14	0.0275	SSOP-28	\$14.40
DAC8801	R-2R	14	0.5	1	Serial, SPI	\pm V _{REF} /MDAC	Ext	0.0061	14	0.025	MSOP-8, SON-8	\$5.50
DAC7512	String	12	10	1	Serial, SPI	V _{CC}	Ext	0.38	12	0.7	VSSOP-8, SOT23-6	\$1.45
DAC7513	String	12	10	1	Serial, SPI	+V _{REF}	Ext	0.38	12	0.5	VSSOP-8, SSOP-8	\$1.45
DAC7571	String	12	10	1	Serial, I ² C	+V _{REF}	Ext	0.096	12	0.7	SOP-6, SOT23-6	\$1.55
DAC7573	String	12	10	4	Serial, I ² C	+V _{REF}	Ext	0.096	12	3	TSSOP-16	\$6.15
DAC7574	String	12	10	4	Serial, I ² C	+V _{REF}	Ext	0.096	12	3	MSOP-10	\$6.15
DAC7611	R-2R	12	7	1	Serial, SPI	4.096	Int	0.012	12	2.5	PDIP-8, SOIC-8	\$2.55
DAC7612	R-2R	12	7	2	Serial, SPI	4.096	Int	0.012	12	3.75	SOIC-8	\$2.70
DAC7613	R-2R	12	10	1	P12	+V _{REF} , \pm V _{REF}	Ext	0.012	12	1.8	SSOP-24	\$2.50
DAC7614	R-2R	12	10	4	Serial, SPI	+V _{REF} , \pm V _{REF}	Ext	0.012	12	20	PDIP-16, SOIC-16, SSOP-20	\$6.70
DAC7615	R-2R	12	10	4	Serial, SPI	+V _{REF} , \pm V _{REF}	Ext	0.012	12	20	PDIP-16, SOIC-16, SSOP-20	\$6.70
DAC7616	R-2R	12	10	4	Serial, SPI	+V _{REF} , \pm V _{REF}	Ext	0.012	12	3	SOIC-16, SSOP-20	\$5.40
DAC7617	R-2R	12	10	4	Serial, SPI	+V _{REF} , \pm V _{REF}	Ext	0.012	12	3	SOIC-16, SSOP-20	\$5.40
DAC7621	R-2R	12	7	1	P12	4.096	Int	0.012	12	2.5	SSOP-20	\$2.75
DAC7624	R-2R	12	10	4	P12	+V _{REF} , \pm V _{REF}	Ext	0.012	12	20	PDIP-28, SOIC-28	\$10.25
DAC7625	R-2R	12	10	4	P12	+V _{REF} , \pm V _{REF}	Ext	0.012	12	20	PDIP-28, SOIC-28	\$10.25
DAC7714	R-2R	12	10	4	Serial, SPI	+V _{REF} , \pm V _{REF}	Ext	0.012	12	45	SOIC-16	\$11.45
DAC7715	R-2R	12	10	4	Serial, SPI	+V _{REF} , \pm V _{REF}	Ext	0.012	12	45	SOIC-16	\$11.45
DAC7724	R-2R	12	10	4	P12	+V _{REF} , \pm V _{REF}	Ext	0.012	12	45	PLCC-28, SOIC-28	\$11.85
DAC7725	R-2R	12	10	4	P12	+V _{REF} , \pm V _{REF}	Ext	0.012	12	45	PLCC-28, SOIC-28	\$11.85
DAC7551	String	12	5	1	Serial, SPI	+V _{REF}	Ext	0.012	12	0.27	SON-12	\$1.40
DAC7552	String	12	5	2	Serial, SPI	+V _{REF}	Ext	0.024	12	0.675	QFN-16	\$2.35
DAC7554	String	12	5	4	Serial, SPI	+V _{REF}	Ext	0.0244	12	3.5	MSOP-10	\$5.60
DAC7558	String	12	5	8	Serial, SPI	+V _{REF}	Ext	0.012	12	4.5	QFN-32	\$10.40
DAC811	R-2R	12	4	1	P12	+10, \pm 5, 10	Int	0.006	12	625	CDIP SB-28, PDIP-28, SOIC-28	\$11.00
DAC813	R-2R	12	4	1	P12	+10, \pm 5, 10	Int/Ext	0.006	12	270	PDIP-28, SOIC-28	\$12.60
TLV5614	String	12	3	4	Serial, SPI	+V _{REF}	Ext	0.1	12	3.6	SOIC-16, TSSOP-16	\$7.45
TLV5616	String	12	3	1	Serial, SPI	+V _{REF}	Ext	0.1	12	0.9	VSSOP-8, PDIP-8, SOIC-8	\$2.60
TLV5618A	String	12	2.5	2	Serial, SPI	+V _{REF}	Ext	0.08	12	1.8	CDIP-8, PDIP-8, SOIC-8, LCCC-20	\$4.75
DAC7545	R-2R	12	2	1	P12	\pm V _{REF} /MDAC	Ext	0.012	12	30	SOIC-20	\$5.25
DAC7541	R-2R	12	1	1	P12	\pm V _{REF} /MDAC	Ext	0.012	12	30	PDIP-18, SOP-18	\$6.70
DAC8043	R-2R	12	1	1	Serial, SPI	\pm V _{REF} /MDAC	Ext	0.012	12	2.5	SOIC-8	\$5.25
TLV5610	String	12	1	8	Serial, SPI	+V _{REF}	Ext	0.4	12	18	SOIC-20, TSSOP-20	\$8.50

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.

String and R-2R DACs



String and R-2R DACs Selection Guide (Continued)

Device	Architecture	Res. (Bits)	Settling Time (μ s)	Number of Output DACs	Interface	Output (V)	V _{REF}	Linearity (%)	Monotonic (Bits)	Power (mW) (typ)	Package(s)	Price ¹
TLV5613	String	12	1	1	P8	+V _{REF}	Ext	0.1	12	1.2	SOIC-20, TSSOP-20	\$2.60
TLV5619	String	12	1	1	P12	+V _{REF}	Ext	0.08	12	4.3	SOIC-20, TSSOP-20	\$2.60
TLV5630	String	12	1	8	Serial, SPI	+V _{REF}	Int/Ext	0.4	12	18	SOIC-20, TSSOP-20	\$8.85
TLV5633	String	12	1	1	P8	+2, 4	Int/Ext	0.08	12	2.7	SOIC-20, TSSOP-20	\$4.70
TLV5636	String	12	1	1	Serial, SPI	+2, 4	Int/Ext	0.1	12	4.5	SOIC-8, VSSOP-8	\$3.65
TLV5638	String	12	1	2	Serial, SPI	+2, 4	Int/Ext	0.1	12	4.5	SOIC-8, CDIP-8, LCCC-20	\$3.25
TLV5639	String	12	1	1	P12	+2, 4	Int/Ext	0.1	12	2.7	SOIC-20, TSSOP-20	\$3.45
DAC7800	R-2R	12	0.8	2	Serial, SPI	1mA	Ext	0.012	12	1	PDIP-16, SOIC-16	\$13.55
DAC7801	R-2R	12	0.8	2	P12	1mA	Ext	0.012	12	1	PDIP-24, SOIC-24	\$17.95
DAC7802	R-2R	12	0.8	2	P12	1mA	Ext	0.012	12	1	PDIP-24, SOIC-24	\$14.00
DAC7811	R-2R	12	0.2	1	Serial, SPI	\pm V _{REF} /MDAC	Ext	0.0120	12	0.05	MSOP-10, SON-8	\$3.15
TLC5615	String	10	12.5	1	Serial, SPI	+V _{REF}	Ext	0.1	10	0.75	PDIP-8, SOIC-8, VSSOP-8	\$1.90
DAC6571	String	10	9	1	Serial, I ² C	V _{DD}	Ext	0.195	10	0.5	SOP-6	\$1.40
DAC6573	String	10	9	4	Serial, I ² C	+V _{REF}	Ext	0.195	10	1.5	TSSOP-16	\$3.05
DAC6574	String	10	9	4	Serial, I ² C	+V _{REF}	Ext	0.195	10	1.5	VSSOP-10	\$3.05
TLV5604	String	10	3	4	Serial, SPI	+V _{REF}	Ext	0.05	10	3	SOIC-16, TSSOP-16	\$3.70
TLV5606	String	10	3	1	Serial, SPI	+V _{REF}	Ext	0.15	10	0.9	SOIC-8, VSSOP-8	\$1.30
TLV5617A	String	10	2.5	2	Serial, SPI	+V _{REF}	Ext	0.1	10	1.8	SOIC-8	\$2.25
TLV5608	String	10	1	8	Serial, SPI	+V _{REF}	Ext	0.4	10	18	SOIC-20, TSSOP-20	\$4.90
TLV5631	String	10	1	8	Serial, SPI	+V _{REF}	Int/Ext	0.4	10	18	SOIC-20, TSSOP-20	\$5.60
TLV5637	String	10	0.8	2	Serial, SPI	+2, 4	Int/Ext	0.1	10	4.2	SOIC-8	\$3.20
TLC5620	String	8	10	4	Serial, SPI	+V _{REF}	Ext	0.4	8	8	PDIP-14, SOIC-14	\$1.50
TLC5628	String	8	10	8	Serial, SPI	+V _{REF}	Ext	0.4	8	15	PDIP-16, SOIC-16	\$2.45
TLV5620	R-2R	8	10	4	Serial, SPI	+V _{REF}	Ext	0.2	8	6	PDIP-14, SOIC-14	\$1.00
TLV5621	R-2R	8	10	4	Serial, SPI	+V _{REF}	Ext	0.4	8	3.6	SOIC-14	\$1.65
TLV5628	String	8	10	8	Serial, SPI	+V _{REF}	Ext	0.4	8	12	PDIP-16, SOIC-16	\$2.20
DAC5571	String	8	8	1	Serial, I ² C	V _{DD}	Int	0.195	8	0.5	SOP-6	\$0.90
DAC5573	String	8	8	4	Serial, I ² C	+V _{REF}	Ext	0.195	8	1.5	TSSOP-16	\$2.55
DAC5574	String	8	8	4	Serial, I ² C	+V _{REF}	Ext	0.195	8	1.5	VSSOP-10	\$2.55
TLC7225	R-2R	8	5	4	P8	+V _{REF}	Ext	0.4	8	75	SOIC-24	\$2.35
TLC7226	R-2R	8	5	4	P8	\pm V _{REF}	Ext	0.4	8	90	PDIP-20, SOIC-20	\$2.15
TLV5623	String	8	3	1	Serial, SPI	+V _{REF}	Ext	0.2	8	2.1	SOIC-8, VSSOP-8	\$0.99
TLV5625	String	8	3	2	Serial, SPI	+V _{REF}	Ext	0.2	8	2.4	SOIC-8	\$1.70
TLV5627	String	8	2.5	4	Serial, SPI	+V _{REF}	Ext	0.2	8	3	SOIC-16, TSSOP-16	\$2.05
TLV5624	String	8	1	1	Serial, SPI	+2, 4	Int/Ext	0.2	8	0.9	SOIC-8, VSSOP-8	\$1.60
TLV5629	String	8	1	8	Serial, SPI	Ext	Ext	0.4	8	18	SOIC-20, TSSOP-20	\$3.15
TLV5632	String	8	1	8	Serial, SPI	+2, 4	Int/Ext	0.4	8	18	SOIC-20, TSSOP-20	\$3.35
TLV5626	String	8	0.8	2	Serial, SPI	+2, 4	Int/Ext	0.4	8	4.2	SOIC-8	\$1.90
TLC7524	R-2R	8	0.1	1	P8	1mA	Ext	0.2	8	5	PDIP-16, PLCC-20, SOIC-16, TSSOP-16	\$1.45
TLC7528	R-2R	8	0.1	2	P8	1mA	Ext	0.2	8	7.5	PDIP-20, PLCC-20, SOIC-20, TSSOP-20	\$1.55
TLC7628	R-2R	8	0.1	2	P8	2mA	Ext	0.2	8	20	SOIC-20, PDIP-20	\$1.45

¹Suggested resale price in U.S. dollars in quantities of 1,000.Preview products are listed in **bold blue**.

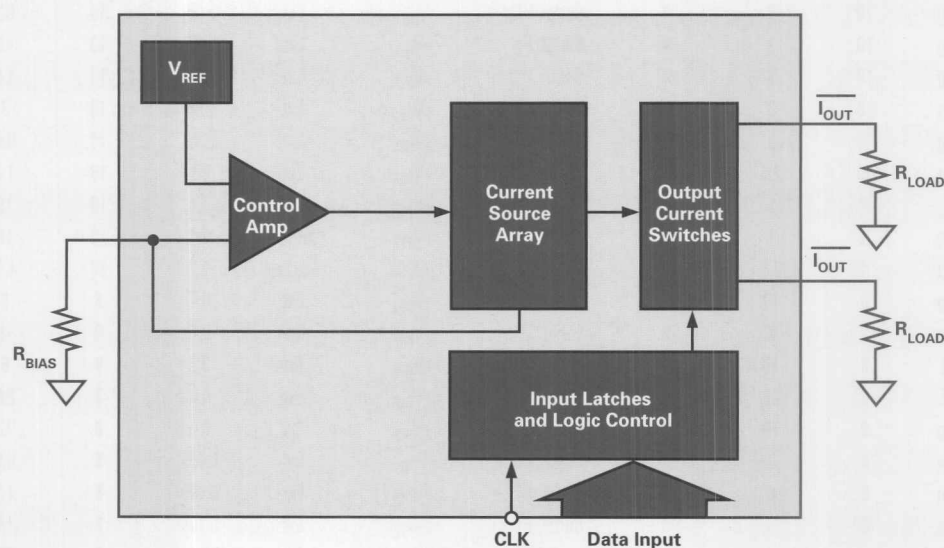


Current Steering DACs

Modern high-speed DACs, fabricated on submicron CMOS or BiCMOS processes, have reached new performance levels with update rates of 500MSPS and resolutions of 14- or even 16-bits. In order to realize such high update rates and resolutions, the DACs employ a current-steering architecture with segmented current sources. The core element within the monolithic DAC is the current source array designed to deliver the full-scale output current, typically 20mA. An internal decoder addresses the differential current switches each time the DAC is updated.

Steering the currents from all current sources to either of the differential outputs forms a corresponding signal output current. Differential signaling is used to improve the dynamic performance while reducing the output voltage swing that is developed across the load resistors. Ideally, this signal voltage amplitude should be as small as possible to maintain optimum linearity of the DAC. The upper limit of this signal voltage and consequently the load resistance is defined by the output voltage compliance specification.

The segmented current-steering architecture leads to a significant reduction in circuit complexity and consequently in reduced glitch energy. This translates into an overall improvement of the DAC's linearity and ac performance. As new system architectures require the synthesis of output frequencies in the 100s of MHz, an approach often referred to as "direct-IF" achieves high update rates, while maintaining excellent dynamic performance.



Current Steering DACs



Low-Noise, 16-Bit, 500MSPS Dual DAC DAC5687

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/DAC5687

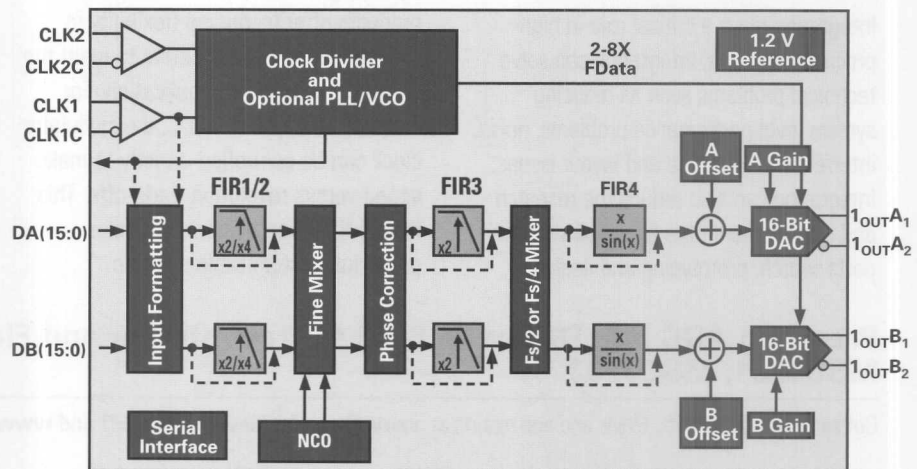
Key Features

- Uniquely suited for direct upconversion architecture
- Complete IQ compensation including offset, gain and phase
- Selectable 2x – 8x interpolation
- Flexible input options
 - Programmable 32-bit NCO and $F_s/4$ or $F_s/2$ mixer
- High performance:
 - SNR: 75dBFS at 25MHz, 500MSPS

Applications

- Communications transmit channel
- Enables software-defined radio
- 2G, 3G and 802.16 base station
- Cable modem termination system
- High-end medical imaging

The DAC5687 is a dual-channel 16-bit, high-speed DAC with integrated 2x, 4x and 8x interpolation filters, a complex numerical control oscillator (NCO), onboard clock multiplier, IQ compensation and on-chip voltage reference. The DAC5687 is pin compatible with the DAC5686, requiring only changes in register settings for most applications, and offers additional features and superior linearity, noise, crosstalk and PLL phase noise performance.



DAC5687 functional block diagram.

Current Steering DACs Selection Guide

Device	Res. (Bits)	Supply (V)	Update Rate (MSPS)	Settling Time (ns)	Number of DACs	Power Typ (mW)	DNL Max (±LSB)	INL Max (±LSB)	Package(s)	Price ¹
DAC5687	16	1.8/3.3	500	10.4	2	700	4	4	HTQFP-100	\$22.50
DAC5686	16	1.8/3.3	500	12	2	400	9	12	HTQFP-100	\$19.75
DAC904	14	3.0 to 5.0	165	30	1	170	1.75	2.5	SOP-28, TSSOP-28	\$6.25
DAC5672	14	3.0 to 3.6	200	20	2	330	3	4	TQFP-48	\$13.25
DAC2904	14	3.3 to 5.0	125	30	2	310	4	5	TQFP-48	\$20.19
DAC5675	14	3	400	5	1	820	2	4	HTQFP-48	\$29.45
DAC902	12	3.0 to 5.0	165	30	1	170	1.75	2.5	SOP-28, TSSOP-28	\$6.25
THS5661A	12	3.0 to 5.0	125	35	1	175	2.0	4	SOP-28, TSSOP-28	\$6.25
DAC5662	12	3.0 to 3.6	200	20	2	330	2	2	TQFP-48	\$10.70
DAC2902	12	3.3 to 5.5	125	30	2	310	2.5	3	TQFP-48	\$15.41
DAC2932	12	2.7 to 3.3	40	25	2	29	0.5	2	TQFP-48	\$7.95
DAC5674	12	1.8/3.3	400	20	1	420	2	3.5	HTQFP-48	\$15.00
DAC900	10	3.0 to 5.0	165	30	1	170	0.5	1	SOP-28, TSSOP-28	\$4.25
THS5651A	10	3.0 to 5.0	125	35	1	175	0.5	1	SOP-28, TSSOP-28	\$4.25
DAC2900	10	3.3 to 5.5	125	30	2	310	1	1	TQFP-48	\$6.00
DAC5652	10	3.0 to 3.6	200	20	2	290	1	0.5	TQFP-48	\$7.60
DAC908	8	3.0 to 5.0	165	30	1	170	0.5	0.5	SOP-28, TSSOP-28	\$2.90
THS5641A	8	3.0 to 5.0	100	35	1	100	0.5	1.0	SOP-28, TSSOP-28	\$2.90
THS5602	8	4.75 to 5.25	30	30	1	80	0.5	0.5	SOP-20	\$1.55

¹Suggested resale price in U.S. dollars in quantities of 1,000.



MicroSystems

MicroSystem products combine the use of a well-established microcontroller core with best-of-class analog performance. The microcontroller core and the analog core are integrated together with high-performance peripherals to make a highly integrated system solution. Therefore, MicroSystem products fit well with applications that require high analog performance and high integration.

Integration plays a critical role in high-precision systems. Integration can solve technical problems such as reducing system level performance problems, noise, interference, interface and layout issues. Integration can also reduce the research and development time by simplifying the parts search, prototyping and design.

Furthermore, the key performance parameters of the system are localized, making development and debug more efficient. The benefit is a more robust, reliable and predictable system.

The technical information and design considerations for the analog cores, described in other sections, which are integrated into the MicroSystem product, still apply. However, the MicroSystem products offer increased flexibility in controlling these parameters to meet the specific needs of the application. For instance, with the $\Delta\Sigma$ ADC, the modulator clock can be controlled directly to make speed versus resolution trade-offs. This makes the MicroSystem product a powerful, customizable solution.

Design Considerations

(see data converter architecture section)

MIPS — Millions of Instructions Per Second.

Instruction Cycle — The length of time required to fetch, decode, execute and store the result of an instruction.

Endurance — Flash endurance is defined as the number of erase/write cycles that the memory can withstand without a failure.

Precision ADC and DAC with 8051 Microcontroller and Flash Memory MSC1201, MSC1202

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/MSC1201 and www.ti.com/sc/device/MSC1202

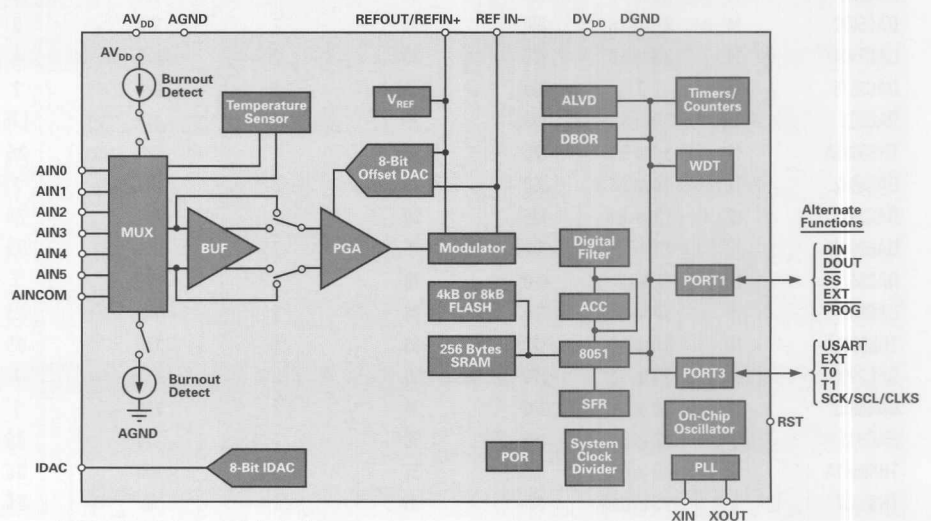
Key Features

- MSC1201: 24-bits no missing codes, 22-bits effective resolution at 10Hz, low noise: 75nV
- MSC1202: 16-bits no missing codes, 16-bits effective resolution at 200Hz, noise: 600nV
- PGA from 1 to 128
- Precision on-chip voltage reference
- 6 differential/single-ended channels
- Microcontroller core:
 - 8051-compatible
 - High-speed: 4 clocks per instruction cycle
 - DC to 33MHz
- Memory:
 - 4kB or 8kB Flash memory
 - Flash memory partitioning
- Peripheral features: 16 digital I/O pins

Applications

- Industrial process control
- Instrumentation
- Liquid/gas chromatography
- Blood analysis
- Smart transmitters
- Portable applications
- DAS systems

The MSC1201Yx/MSC1202Yx are completely integrated families of mixed-signal devices incorporating a high-resolution, $\Delta\Sigma$ ADC, 8-bit IDAC, 6-channel multiplexer, burnout detect current sources, selectable buffered input, offset DAC, PGA, temperature sensor, voltage reference, 8-bit microcontroller, Flash program memory, Flash data memory and Data SRAM. The microcontroller core is an optimized 8051 core that executes up to three times faster than the standard 8051 core, given the same clock source. This makes it possible to run the device at a lower external clock frequency and achieve the same performance at lower power than the standard 8051 core. The MSC1201Yx/MSC1202Yx are designed for high-resolution measurement applications.



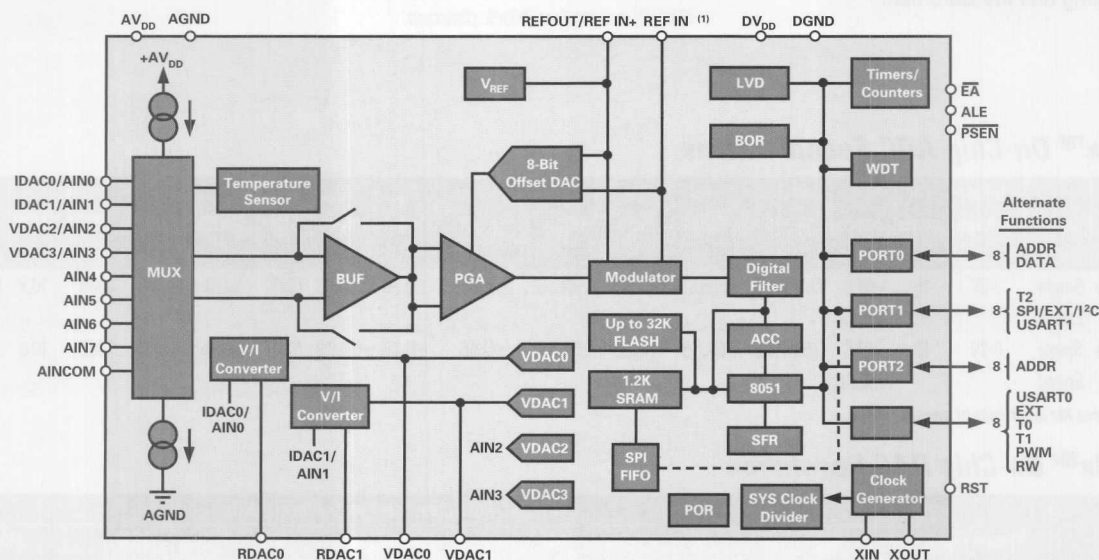
MSC1201 functional block diagram.

8051-Based Intelligent $\Delta\Sigma$ MicroSystems Selection Guide

Device	ADC Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Input Voltage (V)	V _{REF}	CPU Core	Program Memory (kB)	Program Memory Type	SRAM (kB)	Power (mW/V)	DAC Output (Bits)	Price ¹
MSC1200Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	0.2	3/2.7-5.25	8-bit IDAC	\$5.95
MSC1200Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	0.2	3/2.7-5.25	8-bit IDAC	\$6.45
MSC1201Y2	24	1	6 Diff/6 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	0.2	3/2.7-5.25	8-bit IDAC	\$5.60
MSC1201Y3	24	1	6 Diff/6 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	0.2	3/2.7-5.25	8-bit IDAC	\$5.95
MSC1210Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	16-bit PWM	\$8.95
MSC1210Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	16-bit PWM	\$9.85
MSC1210Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	16-bit PWM	\$10.75
MSC1210Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	16-bit PWM	\$12.00
MSC1211Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$17.50
MSC1211Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$17.95
MSC1211Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$19.35
MSC1211Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$20.95
MSC1212Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$16.95
MSC1212Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$17.55
MSC1212Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$18.85
MSC1212Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$20.40
MSC1213Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$12.65
MSC1213Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$13.20
MSC1213Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$14.45
MSC1213Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$15.95
MSC1214Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$12.15
MSC1214Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$12.70
MSC1214Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$13.95
MSC1214Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$15.45
MSC1202Y2	16	2	6 Diff/6 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	0.2	3/2.7-5.25	8-bit IDAC	\$4.60
MSC1202Y3	16	2	6 Diff/6 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	0.2	3/2.7-5.25	8-bit IDAC	\$4.95

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in bold red.



MSC1211 functional block diagram.



Digital Signal Controllers

MCU Controls. DSP Performance. TMS320C28x™

Get samples, datasheets, tools and app reports at: www.ti.com/c2000

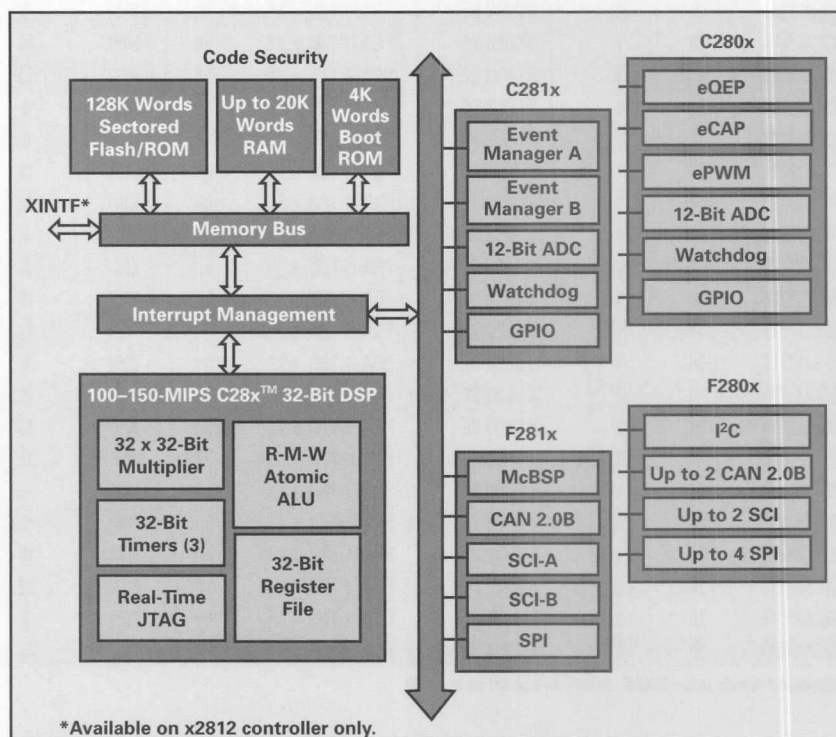
Key Features

- Ultra-fast 20 to 40ns service time to any interrupts
- Powerful 20Mbit/s data logging debug capability
- 32-/64-bit saturation, single-cycle read-modify-write instructions, and 64-/32-bit and 32-/32-bit modulus division
- Enhanced tool suites with C and C++ support
- Unique real-time debugging capabilities
- 32 x 32-bit single-cycle fixed-point MAC
- Dual 16 x 16-bit single-cycle fixed-point MACs
- Supported by 16-bit instructions for improved code efficiency
- Compatible with TMS320C24x™ DSP and TMS320C2xLP source code

Applications

- Automotive
- Industrial automation
- Appliance/white goods
- Power conversion
- Sensing and measurement

TMS320C28x™ digital signal controllers combine the processing performance of TI's DSP technology with the integration and ease-of-use of conventional microcontrollers.



C28x™ controllers block diagram.

TMS320C28x™ On-Chip ADC Specifications

Device ¹	Type	Input	Input Voltage	# of Inputs	Temp	Sampling Speed	Gain	Calibrated Gain	Offset	Calibrated Offset	DNL (max)	INL (max)	SNR	SINAD	THD	SFDR	ENOB	Power	Power Coefficient
TMS320C28x™																			
2810/11/12	Pipeline	Single Ended	0-3V	16	-40°C to 125°C	12.5MSPS	±200LSB	±8LSB	±80LSB	±8LSB	±1LSB	±1.5LSB	62dB	62dB	-68dB	69dB	10.1	165mW	50PPM/C
2801/06/08	Pipeline	Single Ended	0-3V	16	-40°C to 125°C	6.25MSPS	±60LSB	±4LSB	±60LSB	±4LSB	±1LSB	±1.5LSB	67dB	66dB	-74dB	76dB	10.6	60mW	50PPM/C

¹Please see datasheet for most recent specifications.

TMS320C28x™ On-Chip DAC Resolution

Device ¹	System Clock	PWM/DAC Resolution (bits) per Frequency (KHz)							
		20	50	100	250	500	1000	1500	2000
TMS320C28x™									
F2801/06/08 HiRes PWM	100 MHz	18.1	16.8	15.8	14.4	13.8	12.4	11.9	11.4
Standard PWM	100 MHz	12.3	11	10	8.6	7.6	6.6	6.1	5.6

¹Please see datasheet for most recent specifications.

Digital Signal Controllers/Microcontrollers



TMS320C28x™ Controller Generation

		Boot		Flash/		CAP/	#	#	12-Bit				Comm Ports				I/O	Core		1 KU
Device [§]	MIPS	ROM	RAM	ROM	Timers	QEP	Channels	HiRes	Conversion	EMIF	Timer	Other	SPI	SCI	CAN	Pins	Voltage (V)	Packaging	(\$U.S.) [†]	
Flash Devices																				
TMS320F2801-PZA/S/Q [§]	100	8 KB	12 KB	32 KB	9	2/1	6 + 2	3	16 ch/160	–	Y	I ² C	2	1	1	32	1.8	100 LQFP	5.79 [†]	
TMS320F2801-GGMA/S/Q [§]	100	8 KB	12 KB	32 KB	9	2/1	6 + 2	3	16 ch/160	–	Y	I ² C	2	1	1	32	1.8	100 BGA	5.79 [†]	
TMS320F2806-PZA/S/Q [§]	100	8 KB	20 KB	64 KB	15	4/2	12 + 4	4	16 ch/160	–	Y	I ² C	4	2	1	32	1.8	100 LQFP	8.69 [†]	
TMS320F2806-GGMA/S/Q [§]	100	8 KB	20 KB	64 KB	15	4/2	12 + 4	4	16 ch/160	–	Y	I ² C	4	2	1	32	1.8	100 BGA	8.69 [†]	
TMS320F2808-PZA/S/Q [§]	100	8 KB	36 KB	128 KB	15	4/2	12 + 4	4	16 ch/160	–	Y	I ² C	4	2	2	32	1.8	100 LQFP	11.52 [†]	
TMS320F2808-GGMA/S/Q [§]	100	8 KB	36 KB	128 KB	15	4/2	12 + 4	4	16 ch/160	–	Y	I ² C	4	2	2	32	1.8	100 BGA	11.52 [†]	
TMS320F2810-PBKA/S/Q [§]	150	8 KB	36 KB	128 KB	7	6/2	16	–	16 ch/80	–	Y	McBSP	1	2	1	56	1.9	128 LQFP	13.81	
TMS320F2811-PBKA/S/Q [§]	150	8 KB	36 KB	256 KB	7	6/2	16	–	16 ch/80	–	Y	McBSP	1	2	1	56	1.9	128 LQFP	14.73	
TMS320F2812-GHHA/S/Q [§]	150	8 KB	36 KB	256 KB	7	6/2	16	–	16 ch/80	Y	Y	McBSP	1	2	1	56	1.9	179 BGA	15.65	
TMS320F2812-PGFA/S/Q [§]	150	8 KB	36 KB	256 KB	7	6/2	16	–	16 ch/80	Y	Y	McBSP	1	2	1	56	1.9	176 LQFP	15.65	
RAM-Only Devices																				
TMS320R2811-PBKA/Q [§]	150	8 KB	40 KB	–	7	6/2	16	–	16 ch/80	–	Y	McBSP	1	2	1	56	1.9	128 LQFP	9.11	
TMS320R2812-GHHA/Q [§]	150	8 KB	40 KB	–	7	6/2	16	–	16 ch/80	Y	Y	McBSP	1	2	1	56	1.9	179 BGA	10.63	
TMS320R2812-PGFA/Q [§]	150	8 KB	40 KB	–	7	6/2	16	–	16 ch/80	Y	Y	McBSP	1	2	1	56	1.9	176 LQFP	10.63	
ROM Devices																				
TMS320C2810-PBKA/Q [§]	150	8 KB	36 KB	128 KB	7	6/2	16	–	16 ch/80	–	Y	McBSP	1	2	1	56	1.9	128 LQFP	7.05 [†]	
TMS320C2811-PBKA/Q [§]	150	8 KB	36 KB	256 KB	7	6/2	16	–	16 ch/80	–	Y	McBSP	1	2	1	56	1.9	128 LQFP	8.22 [†]	
TMS320C2812-GHHA/Q [§]	150	8 KB	36 KB	256 KB	7	6/2	16	–	16 ch/80	Y	Y	McBSP	1	2	1	56	1.9	179 BGA	9.59 [†]	
TMS320C2812-PGFA/Q [§]	150	8 KB	36 KB	256 KB	7	6/2	16	–	16 ch/80	Y	Y	McBSP	1	2	1	56	1.9	176 LQFP	9.59 [†]	

[†] Prices are quoted per unit in U.S. dollars at 1 KU quantities. Prices represent year 2005 suggested resale pricing.

[§] A = –40° to 85°C; S = –40 to 125°C (10% adder over A); Q = –40 to 125°C, Q100 qualified (15% adder over S)

All devices are available in PB-free Green packaging.

[†] Minimum volumes for C281x devices are 10 KU with NRE of \$11,000.

[†] Production scheduled for 3Q05.

Ultra-Low-Power, 16-Bit RISC Flash MCU with LCD Driver MSP430F43x

Get samples, datasheets, EVMs and app reports at: www.ti.com/msp430

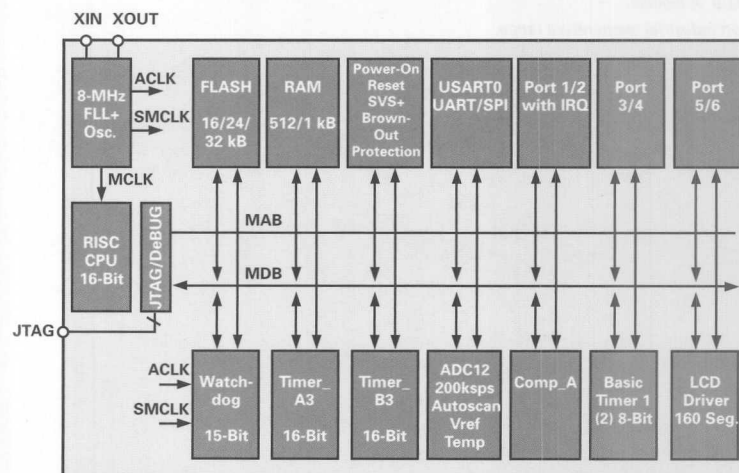
Key Features

- Ultra-low power consumption of 1µA in standby mode
- High-performance integrated analog and digital peripherals including 200ksp/s, 12-bit ADC, LCD driver, hardware multiplier, comparator and SVS
- Serial Communication Interface (USART) functions as Asynchronous UART or Synchronous SPI interface
- In-system programmable Flash permits last-minute code changes, field upgrades and data logging to Flash
- MSP-FET430P440 development tool for \$99
- Packaging: 80-pin or 100-pin LQFP

Applications

- Utility metering
- Portable instrumentation
- Intelligent sensing

With the highest levels of analog integration, including integrated LCD drivers, combined with industry leading ultra-low power consumption, the MSP430F43x is now available in a smaller 80-pin LQFP package for cost, power and space-sensitive applications.



MSP430F43x functional block diagram.



Microcontrollers

MSP430 Ultra-Low-Power Microcontrollers Selection Guide

(C) ROM (F) Flash	Program	SRAM	I/O	DMA	LCD (8-Bit) Basic Timer	Timer A 16-Bit Channels ²	Timer B 16-Bit Channels ²	USART	SVS	Brown- Out Reset	MPY	Comp A	Temp Sensor	ADC	Additional Analog	Package(s)	Price ¹
Flash/ROM Based F4xx Family with LCD Driver and 16-Bit Watchdog (V_{CC} 1.8-3.6V)																	
MSP430F412	4KB	256	48	—	96	3	—	—	✓	✓	—	✓	—	slope	—	64PM, RTD	\$2.60
MSP430C412	4KB	256	48	—	96	3	—	—	✓	✓	—	✓	—	slope	—	64PM, RTD	\$1.90
MSP430F413	8KB	256	48	—	96	3	—	—	✓	✓	—	✓	—	slope	—	64PM, RTD	\$2.95
MSP430C413	8KB	256	48	—	96	3	—	—	✓	✓	—	✓	—	slope	—	64PM, RTD	\$2.10
MSP430F415	16KB	512	48	—	96	3,5	—	—	✓	✓	—	✓	—	slope	—	64PM	\$3.40
MSP430F417	32KB	1024	48	—	96	3,5	—	—	✓	✓	—	✓	—	slope	—	64PM	\$3.90
MSP430FW423	8KB	256	48	—	96	3,5	—	—	✓	✓	✓	✓	—	slope	Flow-meter	64PM	\$3.75
MSP430FW425	16KB	512	48	—	96	3,5	—	—	✓	✓	✓	✓	—	slope	Flow-meter	64PM	\$4.05
MSP430FW427	32KB	1024	48	—	96	3,5	—	—	✓	✓	✓	✓	—	slope	Flow-meter	64PM	\$4.45
MSP430F4250 ²	16KB	256	32	—	56	3	—	—	—	✓	—	—	✓	SD16	DAC12	48DL	\$3.10
MSP430F4260 ²	24KB	256	32	—	56	3	—	—	—	✓	—	—	✓	SD16	DAC12	48DL	\$3.45
MSP430F4270 ²	32KB	256	32	—	56	3	—	—	—	✓	—	—	✓	SD16	DAC12	48DL	\$3.80
MSP430F423	8KB	256	14	—	128	3	—	1	✓	✓	—	—	✓	SD16	—	64PM	\$4.50
MSP430F425	16KB	512	14	—	128	3	—	1	✓	✓	—	—	✓	SD16	—	64PM	\$4.95
MSP430F427	32KB	1024	14	—	128	3	—	1	✓	✓	—	—	✓	SD16	—	64PM	\$5.40
MSP430FE423	8KB	256	14	—	128	3	—	1	✓	✓	✓	—	✓	SD16	E meter	64PM	\$4.85
MSP430FE425	16KB	512	14	—	128	3	—	1	✓	✓	✓	—	✓	SD16	E meter	64PM	\$5.45
MSP430FE427	32KB	1024	14	—	128	3	—	1	✓	✓	✓	—	✓	SD16	E meter	64PM	\$5.95
MSP430F435	16KB	512	48	—	128/160	3	3	1	✓	✓	—	✓	✓	8Ch ADC12	—	80PN, 100PZ	\$4.45
MSP430F436	24KB	1024	48	—	128/160	3	3	1	✓	✓	—	✓	✓	8Ch ADC12	—	80PN, 100PZ	\$4.70
MSP430F437	32KB	1024	48	—	128/160	3	3	1	✓	✓	—	✓	✓	8Ch ADC12	—	80PN, 100PZ	\$4.90
MSP430FG437	32KB	1024	48	✓	128	3	3	1	✓	✓	—	✓	✓	12Ch ADC12	DAC12, OPAMP	80PN	\$6.50
MSP430FG438	48KB	2048	48	✓	128	3	3	1	✓	✓	—	✓	✓	12Ch ADC12	DAC12, OPAMP	80PN	\$7.35
MSP430FG439	60KB	2048	48	✓	128	3	3	1	✓	✓	—	✓	✓	12Ch ADC12	DAC12, OPAMP	80PN	\$7.95
MSP430F447	32KB	1024	48	—	160	3	7	2	✓	✓	✓	✓	✓	8Ch ADC12	—	100PZ	\$5.75
MSP430F448	48KB	2048	48	—	160	3	7	2	✓	✓	✓	✓	✓	8Ch ADC12	—	100PZ	\$6.50
MSP430F449	60KB	2048	48	—	160	3	7	2	✓	✓	✓	✓	✓	8Ch ADC12	—	100PZ	\$7.05

¹Suggested resale price in U.S. dollars in quantities of 1,000.

²Contrast controller with LCD_A module.

All production parts support industrial temperature range.

Preview products are listed in **bold blue**.

Code Composer Studio™ IDE Data Converter Plug-In (DCP)



TI's Data Converter Plug-In (DCP) is a free development tool that allows the creation of initialization data and configuration software for TI data converters from within the Integrated Development Environment (IDE) of Code Composer Studio™. It provides easy-to-use windows for "point-and-click" data converter configuration from within the IDE, preventing illegal combinations of settings. The DCP dialog allows the user to select all the different settings for the data converter from a single screen and

to automatically generate the interface software with a single mouse click. The generated well-documented C-source files contain all functions necessary to talk to the external data converter and to set up all of the registers internal to this device. The minimum function set includes read/write functions (single words and blocks of data), initialization functions and data structures and some device-specific functions like power down.

The generated code is to a great extent hardware independent, so it can be used together with the analog evaluation modules (EVMs) from our modular EVM system, our DSP Starter Kits (DSK) or with your own custom board.

To download your free 3.5 version of the Data Converter Plug-In for Code Composer Studio, please go to www.ti.com/sc/dcplug-in

New devices are added to the tool on a regular basis.

Data Converter Plug-In (DCP) for Code Composer Studio™ IDE Supported Devices in Version 3.5

Device	Description	C28x™	C54x™	C55x™	C6000™	C64x™
ADCs						
ADS803/4/5	12-Bit, 5/10/20 MSPS, 1-Channel	—	—	✓	✓	✓
ADS1216/17/18	24-Bit, 0.78kSPS, 8-Channel	—	✓	✓	✓	—
ADS1240/41	24-Bit, 15SPS, 4/8-Channel	—	✓	—	✓	—
ADS1251/52	24-Bit, 20/40kSPS, 1-Channel	—	✓	✓	✓	—
ADS1253/54	24-Bit, 20kSPS, 4-Channel, 1.8-3.6V/5V	—	✓	—	✓	—
ADS1271	24-Bit, 105kSPS, 1-Channel	—	—	—	✓	—
ADS1601/02	16-Bit, 1.25/2.5MSPS, 1-Channel	—	—	✓	✓	✓
ADS1605/25	16/18-Bit, 5/1.25MSPS, 1-Channel, 3.3V I/O, 5V Analog	—	—	✓	✓	✓
ADS1606/26	16/18-Bit, 5/1.25MSPS, 1-Channel, 3.3V I/O, 5V Analog, 16 Word FIFO	—	—	✓	✓	✓
ADS7841/44	12-Bit, 200kSPS, 4/8-Channel	—	✓	—	—	—
ADS7861	12-Bit, 500kSPS, 2 + 2-Channel	✓	✓	✓	✓	✓
ADS8320/21/25	16-Bit, 100kSPS, 1-Channel, 2.7-5V	—	✓	—	—	—
ADS8322/23	16-Bit, 500kSPS, 1-Channel, 5V	—	—	✓	✓	✓
ADS8324	14-Bit, 50kSPS, 1-Channel, 1.8-3.6V	—	✓	—	—	—
ADS8361	16-Bit, 500kSPS, 4-Channel	✓	✓	✓	✓	✓
ADS8364	16-Bit, 250kHz, 6-Channel	—	✓	—	✓	✓
ADS8381/83	18-Bit, 570/500kSPS, 1-Channel	—	—	✓	✓	✓
ADS8401/2	16-Bit, 2MSPS, 1-Channel Uni/Bi Polar	—	—	✓	✓	✓
ADS8411/12	16-Bit, 2MSPS, 1-Channel Uni/Bi Polar	—	—	✓	✓	✓
PCM1804	24-Bit, 192kHz, Stereo	—	✓	✓	✓	✓
PCM4202	24-Bit, 192kHz, Stereo	—	✓	✓	✓	✓
THS1007/09	10-Bit, 8MSPS, 4/2-Channel	—	—	—	—	—
THS10064/82	10-Bit, 8MSPS, 4/2-Channel, 16 Word FIFO	✓	✓	✓	✓	✓

Remarks

- C28x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C2800 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C54x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C5400 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C55x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C5500 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C6000:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C6200/C6700 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C64x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C6400 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.

The online version of this table can be found at: www.ti.com/sc/dcplug-in



Code Composer Studio™ IDE Data Converter Plug-In (DCP)

Data Converter Plug-In (DCP) for Code Composer Studio™ IDE Supported Devices in Version 3.5 (Continued)

Device	Description	C28x™	C54x™	C55x™	C6000™	C64x™
ADCs (Continued)						
THS1206	12-Bit, 6MSPS, 4-Channel, 16 Word FIFO	✓	✓	✓	✓	✓
THS1207/09	12-Bit, 8MSPS, 4/2-Channel	—	—	—	—	—
THS12082	12-Bit, 8MSPS, 2-Channel, 16 Word FIFO	✓	✓	✓	✓	✓
THS1401/03/08	14-Bit, 1/3/8MSPS, 1-Channel	—	—	—	—	—
THS14F01/03	14-Bit, 1/3MSPS, 1-Channel, 32 Word FIFO	—	—	—	—	—
TLC1514/18	10-Bit, 400kSPS, 4/8-Channel	—	✓	—	✓	—
TLC2551	12-Bit, 400kSPS, 1-Channel, 5V	—	✓	—	—	—
TLC2552/55	12-Bit, 175kSPS, 2/1-Channel, 5V	—	✓	—	—	—
TLC2554/58	12-Bit, 400kSPS, 4/8-Channel	—	✓	—	—	—
TLC2574/78	12-Bit, 200kSPS, 4/8-Channel, 5V	—	✓	—	—	—
TLC3541	14-Bit, 200kSPS, 1-Channel, 5V	—	✓	—	✓	—
TLC3544/48	14-Bit, 200kSPS, 4/8-Channel, 5V	—	✓	—	—	—
TLC3545	14-Bit, 200kSPS, 1-Channel, 5V	—	✓	—	✓	—
TLC3574/78	14-Bit, 200kSPS, 4/8-Channel, 5V	—	✓	—	—	—
TLC4541/45	16-Bit, 200kSPS, 1-Channel, 5V	—	✓	—	✓	—
TLV1504/08	10-Bit, 200kSPS, 4/8-Channel	—	✓	—	✓	—
TLV1570	10-Bit, 1.25MSPS, 8-Channel	—	✓	—	—	—
TLV1571/78	10-Bit, 1.25MSPS, 1/8-Channel	—	✓	—	✓	—
TLV1572	10-Bit, 1.25MSPS, 1-Channel, S and H	—	✓	—	—	—
TLV2541	12-Bit, 200kSPS, 1-Channel, 2.7-5.5V	—	✓	—	—	—
TLV2542/45	12-Bit, 140-200kSPS, 2/1-Channel, 2.7-5.5V	—	✓	—	—	—
TLV2544/48	12-Bit, 200kSPS, 4/8-Channel	—	✓	—	✓	—
TLV2553/56	12-Bit, 200kSPS, 11-Channel, Int. Reference	✓	✓	✓	✓	✓
DACs						
DAC1220/21	16-Bit, 1-Channel, 2ms	—	—	—	—	—
DAC7512/13	12-Bit, 1-Channel, 2.7-5.5V, Int/Ext Reference	—	—	—	—	—
DAC8501	16-Bit, 1-Channel, 2.7-5.5V, 10µs, MDAC	✓	✓	✓	✓	✓
DAC8531	16-Bit, 1-Channel, 2.7-5.5V, 10µs	✓	✓	✓	✓	✓
DAC8532/34	16-Bit, 2/1-Channel, 2.7-5.5V, 10µs	✓	✓	✓	✓	✓
DAC8580	16-Bit, 1-Channel, 1µs	—	—	—	✓	—
TLC5618A	12-Bit, 2-Channel, 5V	—	✓	—	✓ ⁽¹⁾	—
TLV5604/14	12/10-Bit, 3µs, 4-Channel, 2.7-5.5V	—	—	—	—	—
TLV5606/16	10/12-Bit, 1-Channel, 2.7-5.5V	—	✓	—	✓ ⁽¹⁾	—
TLV5608	10-Bit, 1µs, 8-Channel, 2.7-5.5V	—	—	—	—	—
TLV5610	12-Bit, 1µs, 8-Channel, 2.7-5.5V	—	—	—	—	—
TLV5617A/18A	10/12-Bit, 2-Channel, 2.7-5.5V	—	✓	—	✓ ⁽¹⁾	—
TLV5623/25	8-Bit, 1/2-Channel, 2.7-5.5V	—	✓	—	✓ ⁽¹⁾	—

¹These DACs share the same driver.

Remarks

- C28x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C2800 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C54x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C5400 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C55x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C5500 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C6000:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C6200/C6700 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C64x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C6400 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.

The online version of this table can be found at: www.ti.com/sc/dcplug-in

Code Composer Studio™ IDE Data Converter Plug-In (DCP)



Data Converter Plug-In (DCP) for Code Composer Studio™ IDE Supported Devices in Version 3.5 (Continued)

Device	Description	C28x™	C54x™	C55x™	C6000™	C64x™
DACs (Continued)						
TLV5624/26	8-Bit, 1/2-Channel, 2.7-5.5V, Int. Reference	—	✓	—	✓ ⁽¹⁾	—
TLV5629	8-Bit, 1μs, 8-Channel, 2.7-5.5V	—	—	—	—	—
TLV5630/31/32	12/10/8-Bit, 1μs, 8-Channel, 2.7-5.5V	—	—	—	—	—
TLV5636/38	12-Bit, 1/2-Channel, 2.7-5.5V, Int. Reference	—	✓	—	✓ ⁽¹⁾	—
TLV5637	10-Bit, 2-Channel, 2.7-5.5V, Int. Reference	—	✓	—	✓ ⁽¹⁾	—
Codecs						
AIC111	16-Bit, 40kSPS, 1-Channel, 1.3V	—	✓	—	—	—
PCM3002	16-/20-Bit, 48kHz, Stereo	—	✓	—	✓	—
TLV320AIC10	16-Bit, 22kSPS	—	✓	—	✓	—
TLV320AIC11	16-Bit, 22kSPS, 1.1-3.6V I/O	—	✓	—	✓	—
TLV320AIC12K	16-Bit, 26kSPS, 1-Channel	—	✓	✓	✓	✓
TLV320AIC14K	16-Bit, 26kSPS, 1-Channel	—	✓	✓	✓	✓
TLV320AIC20K	16-Bit, 26kSPS, 2-Channel, 3.3V I/O	—	✓	✓	✓	✓
TLV320AIC22C	Dual VOIP Codec	—	✓	✓	✓	✓
TLV320AIC23	24-Bit, 96kHz, Stereo	—	✓	✓	✓	✓
TLV320DAC23	16/20/24/32-Bit, 96kHz, Stereo DAC	—	—	—	—	—
TLC320AIC24K	16-Bit, 26kSPS, 1-Channel, 3.3V I/O	—	✓	✓	✓	✓
TLC320AIC25	16-Bit, 26kSPS, 1-Channel, 1.1V I/O	—	✓	✓	✓	✓
Special Functions						
AFE1230	G.SHDSL Analog Front End	—	—	✓	—	—
AMC7820	Analog Monitoring and Control Circuitry	—	✓	—	✓	—

¹These DACs share the same driver.

Remarks

- C28x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C2800 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C54x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C5400 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C55x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C5500 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C6000:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C6200/C6700 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.
- C64x:** A check-mark in this column indicates that the data converter plug-in generates the interface software for the TMS320C6400 DSP family, which not only configures the data converter, but also the DSP peripheral the device is connected to (e.g. the serial port or the memory interface). If no check-mark is present, only the register settings, but no interface functions are generated.

The online version of this table can be found at: www.ti.com/sc/dcplug-in



Analog Monitoring and Control

Data acquisition system products from TI come with a reputation for high performance and integration along with the design flexibility required for a broad range of applications such as motor control, smart sensors, low-power monitors and control, instrumentation systems, tunable lasers and optical power monitoring.

For motor control and three-phase power control, TI offers the new ADS7869. The ADS7869 is a 12-channel, 12-bit data acquisition system featuring simultaneous sampling with three 12-bit SAR ADCs at 1MSPS with serial or parallel interface for high-speed data transfer and data processing.

The ADS7870 and ADS7871 are complete, low-power data acquisition systems on a single chip and are ideal for portable and battery-powered applications. The ADS7870 is complete with 12-bit ADC with MUX, PGA, internal reference and fast serial interface.

Analog Motor Control Front End with Simultaneous Sampling on Seven S/H Capacitors and Three 1MSPS, 12-Bit, 12-Channel ADCs ADS7869

Get samples, datasheets and app reports at: www.ti.com/sc/device/ADS7869

Key Features

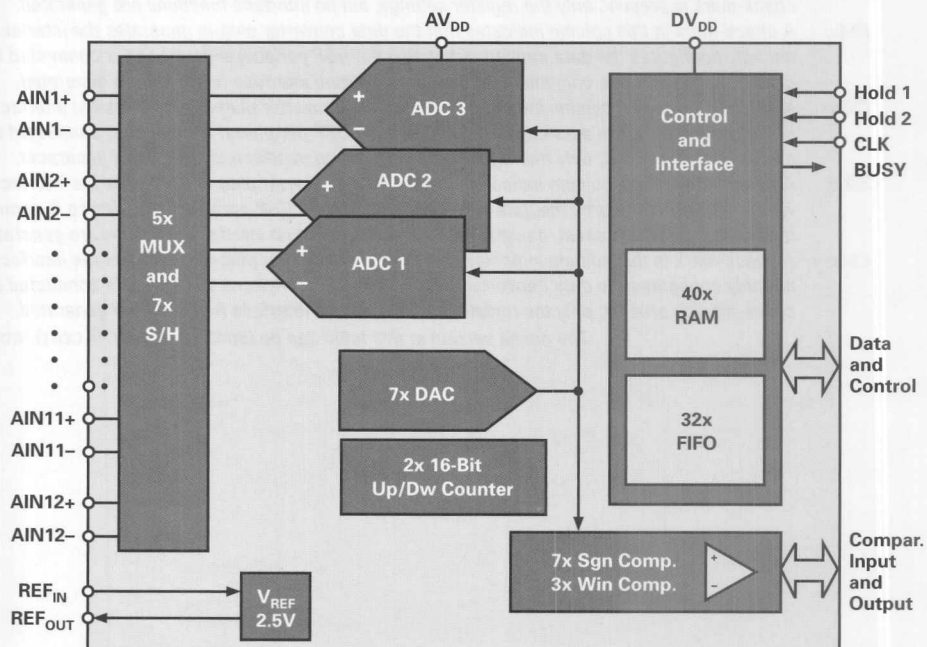
- Five synchronous and two asynchronous S/H amplifiers
- Fully differential inputs
- Flexible digital interface with four modes:
 - One mode 100% software compatible to VECANA01
 - SPI and two parallel modes
- Two up-down counter modules on chip
- Programmable gain adjustment for each input
- Programmable offset STET for each input

Applications

- Motor control

The ADS7869 is a motor control front end that includes three ADCs with a total of seven S/H amplifiers and 12 fully differential input channels. There are four sign comparators connected to four input channels for encoder applications. There are also three additional fully differential inputs; each input is connected to a window comparator and a sign comparator for current measurement.

In addition, the ADS7869 also offers a very flexible digital interface with a parallel port that can be configured to different standards. Furthermore, a serial peripheral interface (SPI) and a specialized serial interface with three data lines (VECANA01 mode) are provided. This allows the ADS7869 to interface with most DSPs or microcontrollers. The chip is specialized for motor control applications. For position sensor analysis, two up-down counters are added on the silicon. This feature ensures that the analog input of the encoder is held at the same point of time as the counter value.



ADS7869 functional block diagram.

Analog Monitoring and Control

Two 1-Bit, 10MHz, 2nd Order $\Delta\Sigma$ Modulator
ADS1205Get samples, datasheets and app reports at: www.ti.com/sc/device/ADS1205

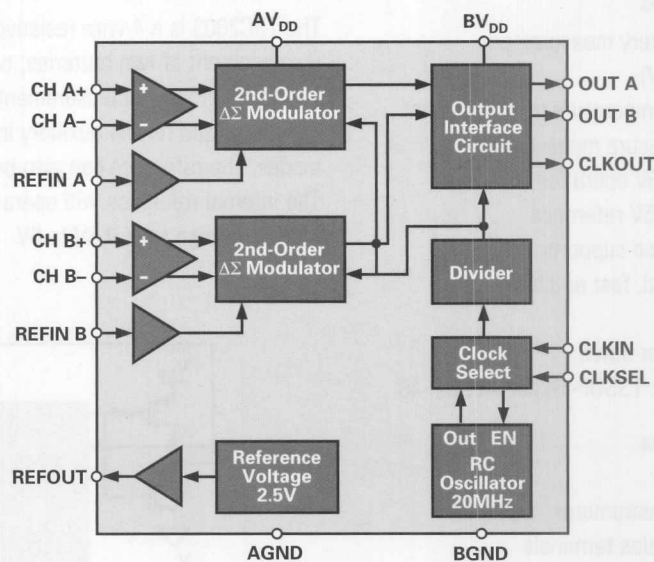
Key Features

- 16-bit resolution
- 14-bit linearity
- $\pm 2.5\text{V}$ input range at 2.5V
- Internal reference voltage: 2%
- Gain error: 0.5%
- Two independent $\Delta\Sigma$ modulators
- Two input reference buffers
- On-chip 20MHz oscillator
- Selectable internal or external clock
- Operating temperature range:
–40°C to +85°C
- Packaging: QFN-24 (4x4)

Applications

- Motor control
- Current measurement
- Industrial process control
- Instrumentation

The ADS1205 is a two-channel, high-performance, $\Delta\Sigma$ modulator with more than 95dB dynamic range, operating from a single +5V supply. The differential inputs are ideal for direct connection to transducers in an industrial environment. With the appropriate digital filter and modulator rate, the device can be used to achieve 16-bit A/D conversion with no missing codes. Effective resolution of 14-bits can be maintained with a digital filter bandwidth of 40kHz at a modulator rate of 10MHz.



ADS1205 functional block diagram.

Analog Monitoring and Control ADCs Selection Guide

Device	Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Interface	Input Voltage (V)	V_{REF}	Linearity (%)	NMC (Bits)	SINAD (dB)	Power (mW)	Package	Price ¹
ADS1216	24	0.78	8 SE/8 Diff	Serial, SPI	PGA (1-128), ± 2.5	Int/Ext	0.0015	24	—	0.6	TQFP-48	\$5.00
ADS1217	24	0.78	8 SE/8 Diff	Serial, SPI	PGA (1-128), ± 5	Int/Ext	0.0012	24	—	0.8	TQFP-48	\$5.00
ADS1218	24	0.78	8 SE/8 Diff	Serial, SPI	PGA (1-128), ± 2.5	Int/Ext	0.0015	24	—	0.8	TQFP-48	\$5.50
ADS8361	16	500	2 x 2 Diff	Serial, SPI	± 2.5 at 2.5	Int/Ext	0.0012	14	83	150	SSOP-24	\$8.75
ADS8364	16	250	1 x 6 Diff	P16	± 2.5 at 2.5	Int/Ext	0.0012	14	82.5	413	TQFP-64	\$18.10
ADS1201	24	1MHz Clock	1 SE/1 Diff	Serial	—	Int/Ext	0.0015	24	—	25	SOIC-16	\$6.15
ADS1202	16	—	1 SE/1 Diff	—	± 0.25	Int/Ext	0.018	16	—	33	TSSOP-8	\$2.50
ADS1203	16	—	1 SE/1 Diff	—	± 0.25	Int/Ext	0.003	16	—	33	TSSOP-8	\$2.70
ADS1204	16	—	4 SE/4 Diff	—	± 2.5 at 2.5	Int/Ext	0.003	16	—	122	QFN-32	\$6.75
ADS1205	16	10MHz Clock	2 Diff	Serial	± 2.5 at 2.5	Int/Ext	0.005	16	—	75	QFN-24	\$3.95
ADS1208	16	10MHz Clock	1 SE/1 Diff	Serial	± 0.125	Int/Ext	0.012	16	—	64	TSSOP-16	\$2.95
ADS7871	14	40	8 SE/4 Diff	Serial, SPI	PGA (1, 2, 4, 8, 10, 16, 20)	Int/Ext	0.03	13	—	6	SSOP-28	\$5.00
ADS7869	12	1000	12 Diff	Serial, SPI/P12	± 2.5 at ± 2.5	Int	0.06	11	71	175	TQFP-100	\$14.60
ADS7861	12	500	2 x 2 Diff	Serial, SPI	± 2.5 at 2.5	Int/Ext	0.024	12	70	25	SSOP-14	\$4.05
ADS7862	12	500	2 x 2 Diff	P12	± 2.5 at 2.5	Int/Ext	0.024	12	71	25	TQFP-32	\$5.70
ADS7864	12	500	3 x 2 Diff	P12	± 2.5 at 2.5	Int/Ext	0.024	12	71	50	TQFP-48	\$6.65
AMC7823	12	200	8 SE I/O DAS	Serial, SPI	5	Int/Ext	0.024	12	74	100	QFN-40	\$13.50
AMC7820	12	100	8 DAS	Serial, SPI	5	Int	0.024	12	72 (typ)	40	TQFP-48	\$9.60
ADS7870	12	50	8 SE	Serial, SPI	PGA (1, 2, 4, 8, 10, 16, 20)	Int	0.06	12	72	4.6	SSOP-28	\$4.15

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.



Touch Screen Controllers

TI offers a progressively integrated, market-leading portfolio of low-power, high-performance resistive touch screen interface/controllers for consumer

applications such as PDAs, internet appliances and Smartphones. These are simple 4- and 5-wire discrete solutions, and highly integrated devices with

touch-screen/audio processors, keypad, and other application specific functions.

I²C Touch Screen Controller TSC2003

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/TSC2003

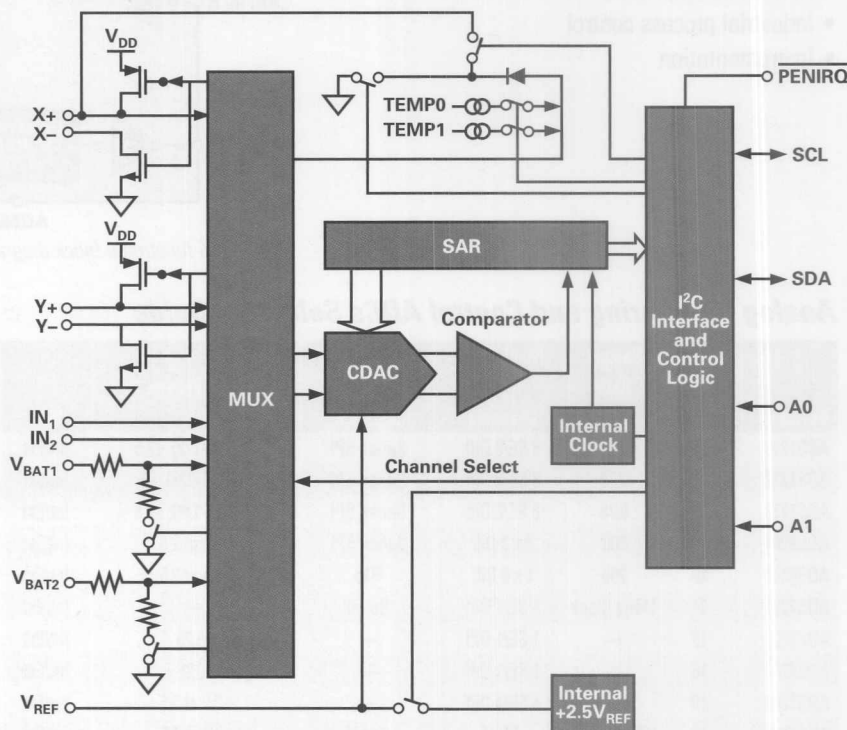
Key Features

- Direct battery measurement (0.5V to 6V)
- On-chip temperature measurement
- Touch-pressure measurement
- 2.5V to 5.5V operation
- Internal 2.5V reference
- I²C interface supports:
 - Standard, fast and high-speed modes
- Auto power down
- Packaging: TSSOP-16 and VFBGA-48

Applications

- PDAs
- Portable instruments
- Point-of-sales terminals
- Pagers
- Touch screen monitors
- Cellular phones

The TSC2003 is a 4-wire resistive touch screen controller. It also features direct measurement of two batteries, two auxiliary analog inputs, temperature measurement and touch pressure measurements. The TSC2003 has an on-chip 2.5V reference that can be utilized for the auxiliary inputs, battery monitors and temperature-measurement modes. The reference can also be powered down when not used to conserve power. The internal reference will operate down to 2.7V supply voltage while monitoring the battery voltage from 0.5V to 6V.



TSC2003 functional block diagram.



Programmable Touch Screen Controller and Audio Codec with Speaker Amp TSC2101

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/TSC2101

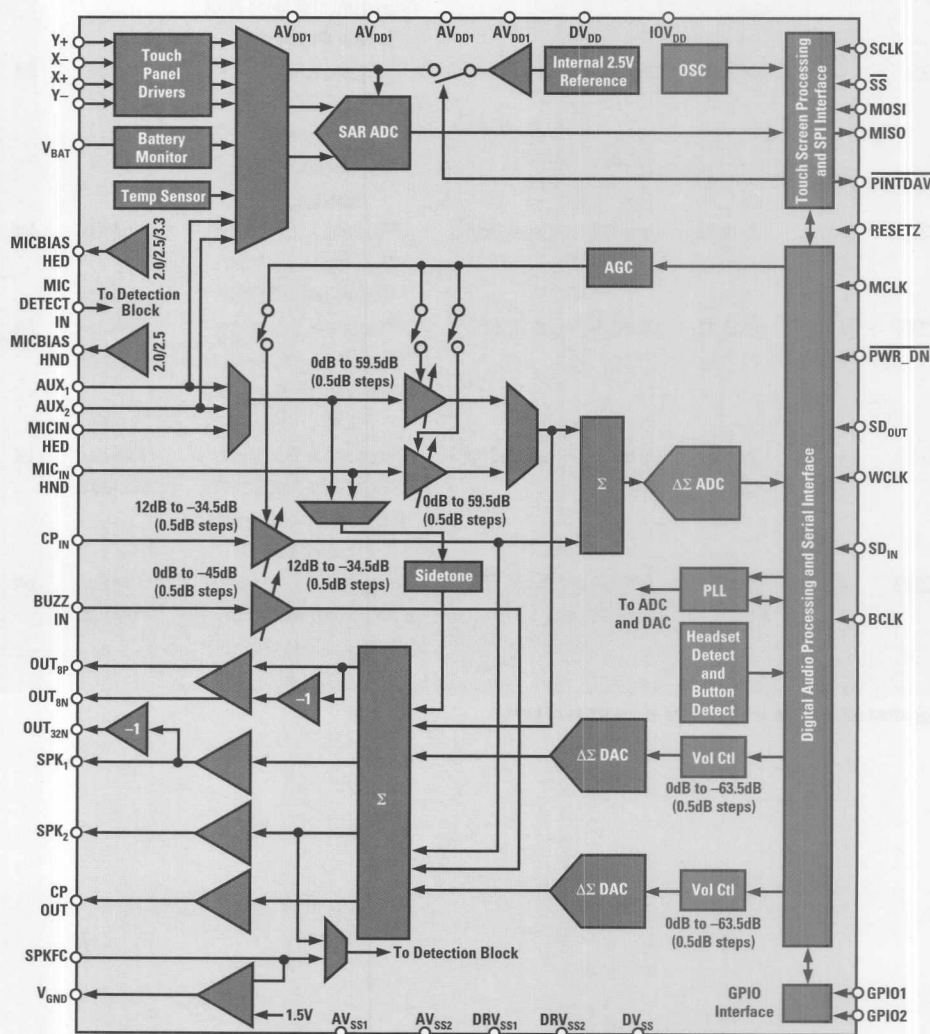
Key Features

- 4-wire touch screen interface with drivers
- Programmable self-controlled timing generation for conversions
- Programmable measurement conversion resolution (up to 12-bits) and averaging
- On-chip temperature and battery measurement (up to 6V)
- Stereo audio DAC and mono audio ADC with hardware automatic gain control, (AGC) up to 48kSPS
- Stereo 16Ω headphone drivers, mono 8Ω speaker driver, mono 32Ω receiver driver, and mono line output
- Six audio inputs can be configured for single-ended or fully-differential operation
- SPI interface for control, I²S bus for audio data
- Packaging: 48-lead 7 x 7mm QFN

Applications

- Smartphones and PDAs
- Cellular phones
- MP3 players

The TSC2101 is a highly integrated combination of "smart" touch-screen controller and audio functionality, intended primarily for Smartphone applications. The "smart" touch screen controller includes 12-bit ADC, drivers for 4-wire resistive touch screens, programmable reference, and auxiliary/battery monitoring with extensive programmability; ie., ADC resolution, averaging and analog timing control. The audio subsystem of the TSC2101 includes stereo DAC and mono ADC with hardware automatic gain control, stereo 16Ω headphone drivers, 32Ω phone receiver driver, bridge-terminated 8Ω speaker driver, and mono output. Six analog inputs are available and can be configured for either single-ended or fully differential operation. In addition, a fully programmable PLL allows highly flexible generation of audio clocks from any applied master clock in the range of 2MHz to 50MHz. The part uses a serial SPI bus for touch screen, measurement, and audio control, and an I²S bus for audio data transfer.



TSC2101 functional block diagram.



Touch Screen Controllers

Touch Screen Controllers Selection Guide

Device	Touch Pane	Res. (Bits)	Sample Rate (kSPS)	Interface	Features	Audio I/O	V _{REF}	Supply Voltage (V)	Package(s)	Price ¹
Touch Screen Only Parts										
ADS7843	4-Wire	12 (8)	Up to 125	Serial, SPI	X, Y, Aux	—	Ext	2.7 to 5.25	SSOP-16	\$1.70
ADS7845	5-Wire	12 (8)	Up to 125	Serial, SPI	X, Y, Aux	—	Ext	2.7 to 5.25	SSOP-16	\$4.20
ADS7846	4-Wire	12 (8)	Up to 125	Serial, SPI	X, Y, Pressure, Aux, V _{BAT} , Temp	—	Int	2.7 to 5.25	SSOP-16, TSSOP-16, QFN-16, BGA-48	\$2.05
TSC2000	4-Wire	8, 10, 12	Up to 125	Serial, SPI	Processor, X, Y, Pressure V _{BAT} , Temp, Aux, DAC	—	Int	2.7 to 3.6	TSSOP-20	\$2.35
TSC2003	4-Wire	12 (8)	Up to 50	Serial, I ² C	X, Y, Pressure, V _{BAT} , Aux, Temp	—	Int	2.7 to 5.25	TSSOP-16, BGA-48	\$2.25
TSC2046	4-Wire	12, (8)	Up to 125	Serial, SPI	X, Y, Pressure, V _{BAT} , Aux, Temp	—	Int	Analog: 2.2 to 5.25 Logic: 1.5 to 5.25	TSSOP-16, QFN-16, BGA-48	\$1.80
TSC2200	4-Wire	8, 10, 12	Up to 125	Serial, SPI	Processor, X, Y, Pressure V _{BAT} , Temp, KP, Aux, DAC	—	Int	2.7 to 3.6	TSSOP-28, QFN-32	\$2.40
Touch Screen + Audio Parts										
TSC2100	4-Wire	8, 10, 12	Up to 125	Serial, SPI/I ² S	Processor, X, Y, Pressure V _{BAT} , Temp, Aux, Audio (Stereo DAC+HP, Mono ADC), Speaker Amp, AGC, PLL	2 Inputs, 2 Outputs	Int	Analog: 2.7 to 3.6 Logic: 1.525 to 1.95 I/O V _{DD} : 1.1 to 3.6	TSSOP-32, QFN-32	\$3.95
TSC2101	4-Wire	8, 10, 12	Up to 125	Serial, SPI/I ² S	Processor, X, Y, Pressure V _{BAT} , Temp, Aux, Cellular Phone I/F, Audio (Stereo DAC+HP Mono ADC+AGC, Spkr Amp), PLL	6 Inputs, 5 Outputs	Int	Analog: 3.0 to 3.6 Logic: 1.65 to 1.95 I/O V _{DD} : 1.1 to 3.6 BVDD: 3.0 to 4.2	QFN-48	\$4.95
TSC2102	4-Wire	8, 10, 12	Up to 125	Serial, SPI/I ² S	Processor, X, Y, Pressure V _{BAT} , Temp, Aux, Audio (Stereo DAC+HP), PLL	2 Outputs	Int	Analog: 2.7 to 3.6 Logic: 1.525 to 1.95 I/O V _{DD} : 2.7 to 3.6	TSSOP-32	\$3.70
TSC2300	4-Wire	8, 10, 12	Up to 125	Serial, SPI/I ² S	Processor, X, Y, Pressure, V _{BAT} , Temp, Aux, Audio (Stereo DAC+HP, Mono ADC) PLL, DAC, Keypad	3 Inputs, 5 Outputs	Int	2.7 to 3.6	TQFP-64	\$4.75
TSC2301	4-Wire	8, 10, 12	Up to 125	Serial, SPI/I ² S	Processor, X, Y, Pressure, V _{BAT} , Temp, Aux, Audio (Stereo Audio Codec+HP), PLL, DAC, Keypad	3 Inputs, 5 Outputs	Int	2.7 to 3.6	TQFP-64, BGA-120	\$4.95
TSC2302	4-Wire	8, 10, 12	Up to 125	Serial, SPI/I ² S	Processor, X, Y, Pressure, V _{BAT} , Temp, Aux, Audio (Stereo Audio Codec+HP), PLL, DAC	3 Inputs, 3 Outputs	Int	2.7 to 3.6	QFN-48	\$4.50

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Voiceband Codecs

TI offers a broad line of low-power, highly integrated, leading-edge voice coding solutions for wireless communications, VoIP, telematic systems, hands-free kits, digital handset/headset, voice recognition

and hearing aids. 16-bit linear DSP codecs offer the highest performance and most flexibility in voice digitization and serial interface to DSPs. PCM codecs perform standard A-law/ μ -law encoding

(ADC) and decoding (DAC) on voice at 8kSPS sampling rate. TI's ultra-low-power codecs are the lowest power voice codecs in the industry.

Low-Power, Highly-Integrated, Programmable 16-Bit, 26KSPS, Dual-Channel CODEC TLV320AIC20K

Get samples, datasheets and app reports at: www.ti.com/sc/device/TLV320AIC20K

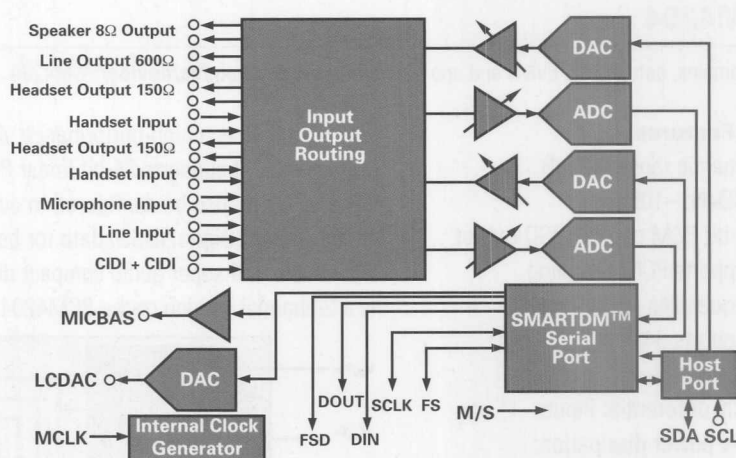
Key Features

- Stereo 16-bit oversampling $\Delta\Sigma$ ADC/DAC
- Programmable sampling rate up to:
 - Max 26KSPS with on-chip IIR/FIR filter
 - Max 104KSPS with IIR/FIR bypassed
- On-chip FIR produced 84-dB SNR for ADC and 92dB SNR for DAC over 13kHz BW
- Host port: 2-wire interface, selectable I²C or S²C
- Differential and single-ended analog input/output
- Fully compatible with common TMS320TM DSP family and μ controller supplies:
 - 1.65V - 1.95V digital core
 - 1.1V - 3.6V digital I/O
 - 2.7V - 3.6V analog

Applications

- Wireless accessories
- Hands-free car kits
- VOIP
- Cable modem

The TLV320AIC20K is a low-cost, highly-integrated, high-performance, dual-voice codec. It features two 16-bit analog-to-digital (A/D) channels and two 16-bit digital-to-analog (D/A) channels, which can be connected to a handset, headset, speaker, microphone or a subscriber line via programmable analog crosspoint.



TLV320AIC20K functional block diagram.

Voiceband Codecs Selection Guide

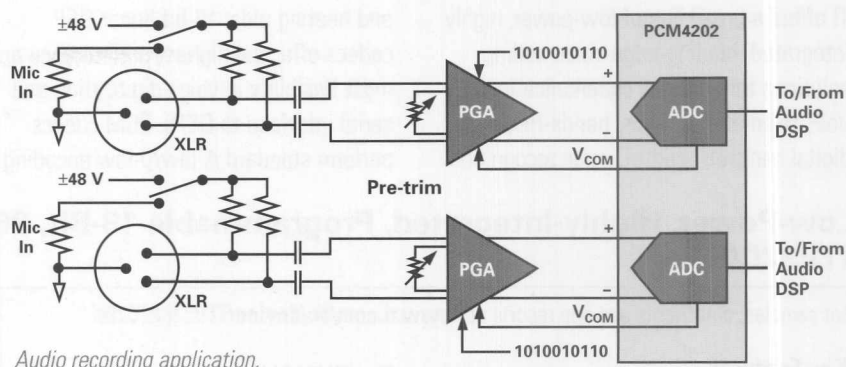
Device	Codec Ch.	Sample Rate (KSPS)	SNR (dB)	Interface DSP	Host Interface	Analog Outputs Ω (# of Outputs)	Core Power Supply (Digital/Analog) (V)	Logic I/O (V)	Power Dissipation (w/o spkr) (mW)	Package(s)	Price ¹
Voiceband											
AIC111	1	40	87	Pulse FS	SPI/DSP	60 (1)	1.1 to 1.5	1.1 to 3.3	0.46	QFN-32, FlipChip	\$4.14
TLV320AIC12K	1	26	90	Pulse FS, SMARTDM TM	I ² C, S ² C	600 (1), 16 (2)	1.8/2.7 to 3.6	1.1 to 3.6	10	TSSOP-30	\$1.80
TLV320AIC14K	1	26	90	Pulse FS, SMARTDM	I ² C, S ² C	600 (1)	1.8/2.7 to 3.6	1.1 to 3.6	10	TSSOP-30	\$1.55
TLV320AIC20K	2	26	90	Pulse FS, SMARTDM	I ² C, S ² C	600 (1), 150 (2), 8 (1)	1.8/2.7 to 3.6	1.1 to 3.6	20	TQFP-48	\$2.50
TLV320AIC24K	2	26	90	Pulse FS, SMARTDM	I ² C, S ² C	600 (1), 150 (2)	1.8/2.7 to 3.6	1.1 to 3.6	20	TQFP-48	\$2.30
TLV320AIC10	1	22	84	Pulse FS, TDM	S ² C, DSP	600 (2)	3 to 5.5	3 to 5.5	39	TQFP-48, VFBGA-80	\$2.40
TLV320AIC11	1	22	84	Pulse FS, TDM	S ² C, DSP	600 (2)	3 to 5.5	1.1 to 3.6	39	TQFP-48	\$2.40
TLC320AD545	1	11	82	Pulse FS	—	600 (1), 8 (1)	3.3 to 5	3.3 to 5	120	TQFP-48	\$3.10
TLV320AIC1103	1	8	65	Pulse FS, A/ μ -law	I ² C	16/32 (2)	2.7 to 3.3	2.7 to 3.3	16	TQFP-32, VFBGA-80	\$2.80
TLV320AIC1106	1	8	65	μ -law	PCM	8/32 (1)	2.7 to 3.3	2.7 to 3.3	13.5	TSSOP-20	\$2.70
TLV320AIC1107	1	8	65	A-law	PCM	8/32 (1)	2.7 to 3.3	2.7 to 3.3	13.5	TSSOP-20	\$2.70
TLV320AIC1109	1	8	65	Pulse FS, A/ μ -law	I ² C	32 (2)	2.7 to 3.3	2.7 to 3.3	16	TQFP-32	\$2.80
TLV320AIC1110	1	8	65	Pulse FS, A/ μ -law	I ² C	8/32 (2)	2.7 to 3.3	2.7 to 3.3	16	TQFP-32, VFBGA-80	\$2.85

¹Suggested resale price in U.S. dollars in quantities of 1,000.



Audio Data Converters

The professional audio market is focused on the recording, signal processing and playback of high-quality audio signals in both the analog and digital domain. ICs designed for the high-performance professional audio space include programmable analog volume controls, audio data converters and digital interface products. These products are the basic building blocks of pro audio systems and with TI's growing line of products combined with many years of expertise, your designs will achieve new levels of sound excellence.



Audio recording application.

High-Performance, 24-Bit, 216kHz, 4-Channel Audio ADC PCM4204

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/PCM4204

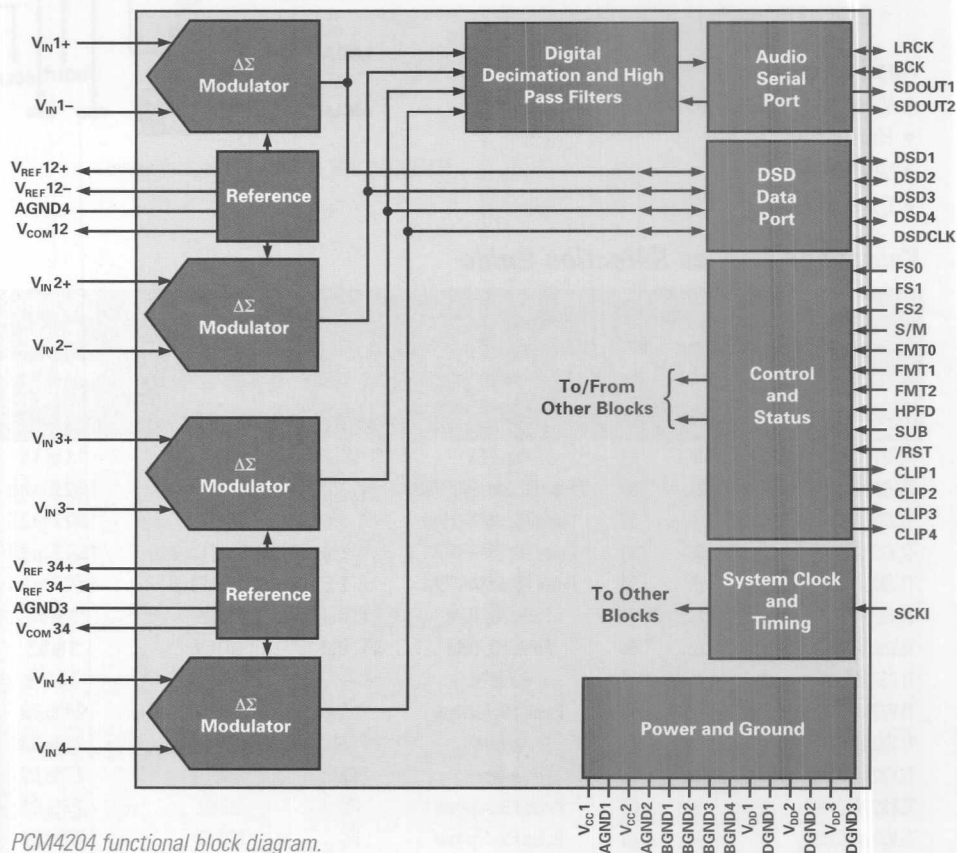
Key Features

- Dynamic range: 118dB
- THD+N: -105dB
- 24-bit PCM or 1-bit DSD output
- Supports PCM sampling frequencies up to 216kHz
- Supports 64x and 128x DSD outputs
- Fully differential inputs
- Low power dissipation:
 - 600mW at $f_s = 48\text{kHz}$
 - 660mW at $f_s = 96\text{kHz}$
- Packaging: HTQFP-64

Applications

- Professional studio equipment:
 - Live sound processing
 - Studio recording
 - Post production
 - Special effects processing
 - Digital recording
- Radio and TV broadcasting
- Musical instruments
- High-end home entertainment
- DVD-audio and super audio compact disc (SACD)

The PCM4204 is a high-performance, 4-channel ADC designed for professional audio applications. It supports 24-bit linear PCM output data with sampling frequencies up to 216kHz. It can also be configured to output either 64x or 128x oversampled, one-bit Direct Stream Digital (DSD) data for both channels. The PCM4204 is also ideal for DVD-audio and super audio compact disc (SACD) recording applications. The PCM4202 is a 2-channel version of the PCM4204.



PCM4204 functional block diagram.



Low-Power, Wide Dynamic Range, 24-Bit, Audio ADC for Wireless Mic and Portable Applications PCM4201

Get samples, datasheets, EVMs and app reports at:

www.ti.com/sc/device/PCM4201

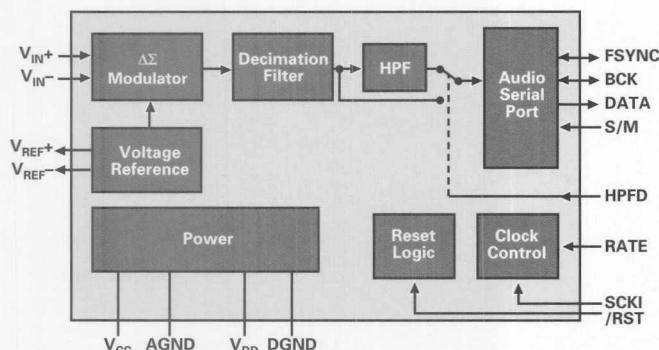
The PCM4201 is a low-power, 24-bit, $\Delta\Sigma$ audio, single channel ADC designed for portable applications, such as digital wireless microphones and battery-operated recording equipment, that require both wide dynamic range and low power consumption. The device features a 24-bit linear PCM data output, with a data format compatible with DSPs and digital audio interface transmitters.

Key Features

- Dynamic range: up to 112dB (A-weighted)
- THD+N: -105dB
- Only 39mW in low power mode
- Digital high-pass filter for DC removal
- Audio serial port:
 - Master or slave mode operation
 - 24-bit linear PCM output data
 - Left justified/DSP-compatible data format
- Three sampling modes:
 - Normal: low power operation up to $f_s = 48\text{kHz}$ with 64x oversampling
 - Normal: high-performance operation up to $f_s = 48\text{kHz}$ with 128x oversampling
 - Double speed: operation up to $f_s = 96\text{kHz}$ with 64x oversampling
- Supply voltage: +5V analog, +1.8V to +3.3V digital
- Package: 16-lead TSSOP

Applications

- Digital wireless microphones
- Portable digital recorders
- Battery-powered audio processing equipment



PCM4201 functional block diagram.

High-Performance, 24-Bit, 212kHz, 4-Channel, Asynchronous Sample Rate Converter SRC4184, SRC4194

Get samples, datasheets, EVMs and app reports at:

www.ti.com/sc/device/SRC4184 and

www.ti.com/sc/device/SRC4194

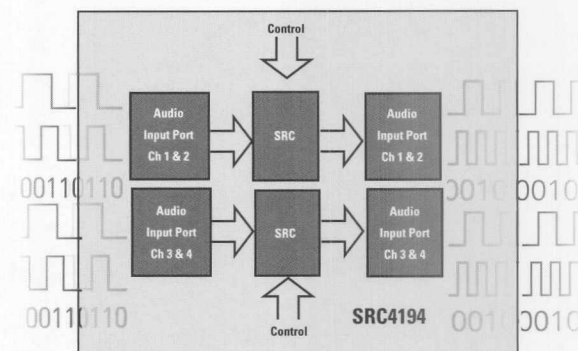
The SRC4194 is a four-channel, asynchronous sample rate converter (ASRC), designed for professional and broadcast audio applications. The SRC4194 combines a wide input-to-output sampling ratio with outstanding dynamic range and ultra-low distortion. The input and output serial ports support the most common audio data formats, as well as a time division multiplexed (TDM) format. This allows the SRC4194 to interface to a wide range of audio data converters, digital audio receivers and transmitters and DSPs. The SRC4184 is a 128dB version of the SRC4194.

Key Features

- Automatic sensing of input-to-output sampling ratio
- Wide input-to-output sampling range: 16:1 to 1:16
- Supports input and output sampling rates up to 212kHz
- Dynamic range: 144dB (-60dBFS input, $\text{BW} = 20\text{Hz}$ to $f_s/2$)
- THD+N: -140dB (0dBFS input, $\text{BW} = 20\text{Hz}$ to $f_s/2$)
- High-performance, linear-phase digital filtering with better than 140dB of stop-band attenuation
- Flexible audio serial ports:
 - Master or slave mode operation
 - Supports I²S, left-justified, right-justified and TDM data formats
 - TDM mode allows daisy-chaining up to four devices
- Packaging: TQFP-64

Applications

- Digital mixing consoles
- Digital audio workstations
- Broadcast studio equipment
- General digital audio processing



SRC4194 functional block diagram.



Audio Data Converters

Low-Power, Highly Integrated Stereo Audio Codecs TLV320AIC32, TLV320AIC33

Get datasheets at: www.ti.com/sc/device/TLV320AIC32 and www.ti.com/sc/device/TLV320AIC33

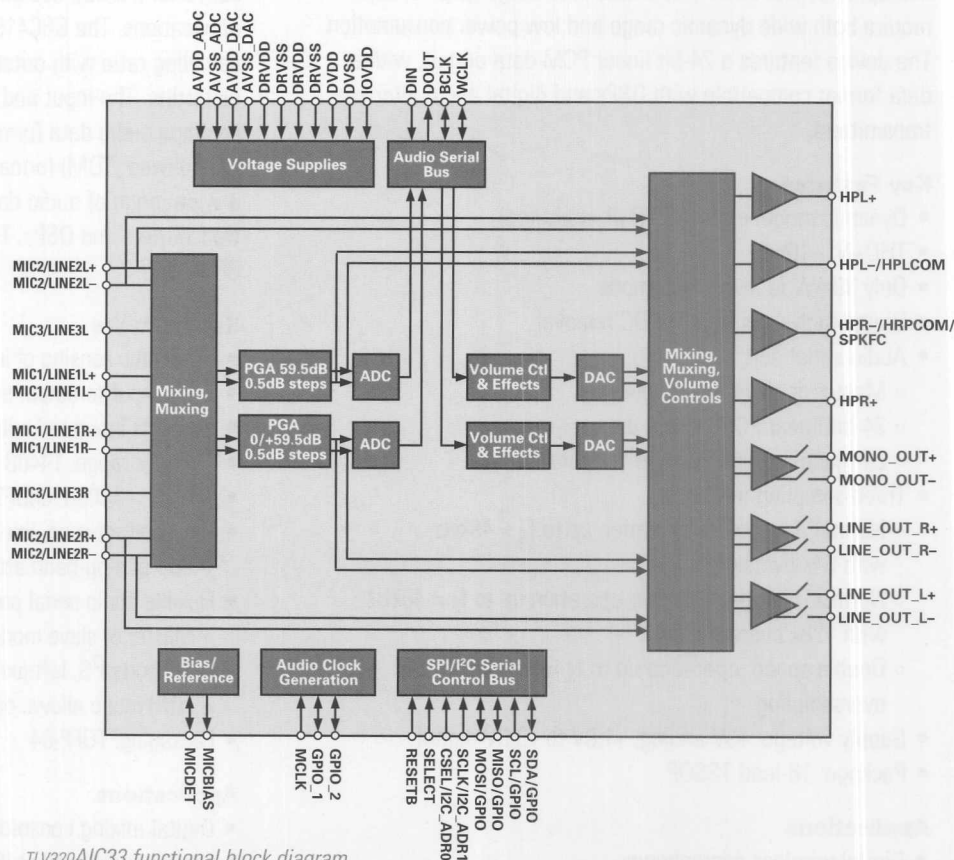
Key Features

- Stereo DAC (103dB) and ADC (92dB) support rates up to 96kSPS
- 103dB stereo playback at 14mW power dissipation
- Stereo headphone drivers and 500mW, 8Ω speaker driver
- Stereo microphone preamps and hardware automatic gain control
- Integrated PLL for flexible audio clock generation
- Programmable digital audio bass/treble/EQ with 3-D effects
- Analog inputs are configurable as single-ended or fully differential
- Dual I²S/PCM bus architecture with DSP and TDM modes (AIC33 only)
- 10 analog inputs, seven output drivers for easy connectivity to multiple devices in a cellular telephony system (AIC33 only)

Applications

- Cellular and smartphones
- Digital still cameras, digital video cameras
- MP3 and portable media players
- PDAs
- Selectable I²C/SPI control interface (AIC33 only)

The TLV320AIC32/33 are highly integrated, low-power stereo codecs for use in a variety of portable audio equipment. The TLV320AIC33 includes 10 analog input pins and seven output drivers and targets cellular telephony applications. The TLV320AIC32 is software-compatible to the TLV320AIC33 and includes stereo headphone and line output drivers and a mono 500mW, 8Ω speaker driver.



TLV320AIC33 functional block diagram.



Low-Power, Stereo Audio Codec with Headphone/Speaker Amplifier and 12-Bit Battery/Temperature/Auxiliary ADC

TLV320AIC26, TLV320AIC28

Get samples, datasheets, EVMs and app reports at: www.ti.com/sc/device/TLV320AIC26 and www.ti.com/sc/device/TLV320AIC28

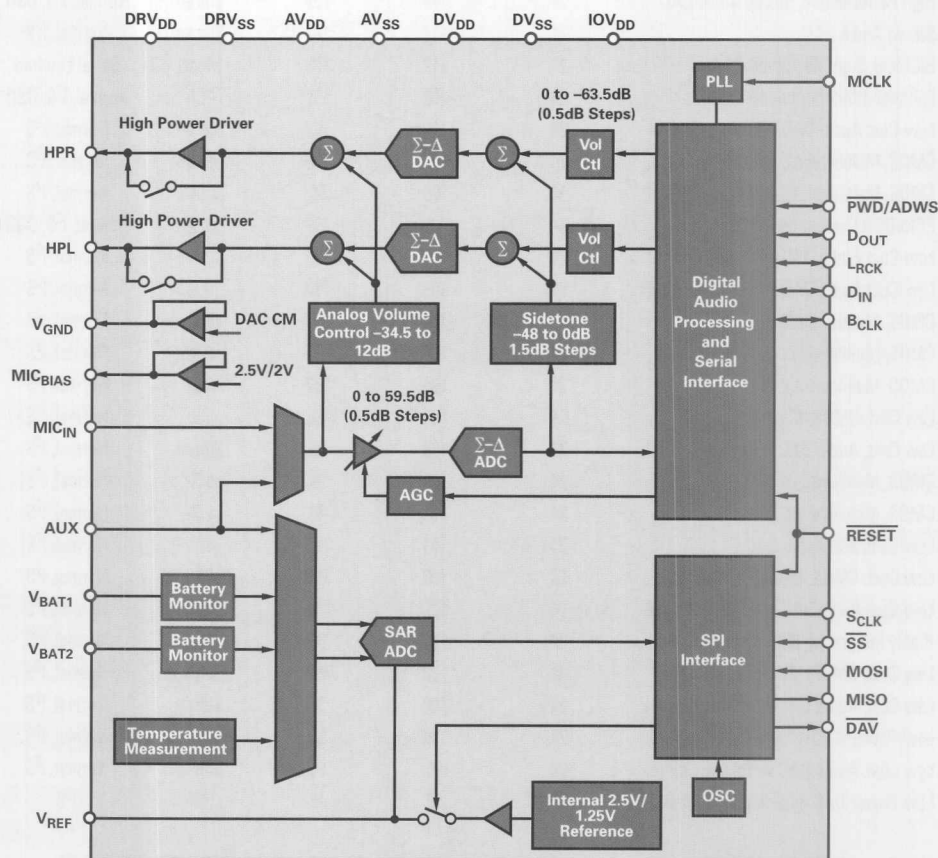
Key Features

- Low-power, high-quality audio codec
- Stereo audio DAC and mono audio ADC
- High-quality 97dBA stereo audio playback at 48kSPS
- Low power: 11mW stereo audio playback at 48kSPS
- On-chip 325mW, 8 Ω speaker driver
- Stereo headphone amplifier with capless output option
- Microphone preamp and hardware automatic gain control
- Integrated PLL for flexible audio clock generation
- Programmable digital audio bass/treble/EQ/de-emphasis
- Direct battery measurement accepts up to 6V input
- On-chip temperature measurement
- SPI and I²S serial interface
- Full power-down control
- Packaging: 32-lead QFN

Applications

- Cellular and smartphones
- MP3 players
- Digital still cameras
- Digital video camcorders

The TLV320AIC26 is a high-performance audio codec with 16-/20-/24-/32-bit, 97dBA stereo playback, mono record functionality at up to 48kSPS. A microphone input includes built-in preamp and hardware automatic gain control, with single-ended or fully differential input capability.



TLV320AIC26 functional block diagram.



Audio DACs and ADCs

Audio DACs and ADCs Selection Guide

Device	Description	Resolution (Bits) (max)	Dynamic Range (dB)	Sampling Rate (kHz) (max)	Config.	Audio Data Format	Power Supply (V)	Package(s)	Price ¹
DACs									
PCM1792/4	High Performance, Stereo Audio DAC	24	128	192	Stereo	Normal, I ² S, DSD	+3.3 and +5	SSOP-28	\$13.65
PCM1796/8	High Performance, Stereo Audio DAC	24	123	192	Stereo	Normal, I ² S, DSD	+3.3 and +5	SSOP-28	\$6.50
PCM4104	High Performance, 4Ch Audio DAC	24	118	192	4Ch	Left-Justified, I ² S	+3.3 and +5	TQFP-48	\$5.95
PCM4108	High Performance, 8Ch Audio DAC	24	118	192	8Ch	Right-Justified, TDM	+3.3 and +5	HTQFP-64	\$9.95
						Left-Justified, I ² S			
						Right Justified, TDM			
PCM1738/30	High Performance, Stereo Audio DAC	24	118	192	Stereo	Normal, I ² S, DSD	+3.3 and +5	SSOP-28	\$5.25
PCM1791	Stereo Audio DAC	24	113	192	Stereo	Normal, I ² S	+3.3 and +5	SSOP-28	\$3.15
PCM1704	BiCMOS, Sign Magnitude DAC	24	112	768	Mono	Serial Latched	±5	SOIC-20	\$13.60
DSD1608	Enhanced Multiformat ΔΣ DAC	24	108	192	8Ch	Normal, I ² S, DSD	+3.3 and +5	TQFP-52	\$6.00
PCM1753/54/55	Low-Cost Audio DAC w/Volume Control	24	106	192	Stereo	Normal, I ² S	+5	SSOP-16	\$1.05
PCM1737/39	CMOS, Multilevel ΔΣ w/Volume Control	24	106	192	Stereo	Normal, I ² S	+3.3 and +5	SSOP-28	\$3.70
PCM1716/28	CMOS, Multilevel ΔΣ w/Volume Control	24	106	96	Stereo	Normal, I ² S	+5	SSOP-28	\$2.40
DSD1702	PCM/DSD Compatible DAC	24	106	192	Stereo	Normal, I ² S, DSD	+3.3 and +5	SSOP-20	\$1.95
PCM1780/81/82	Low-Cost Audio DAC w/Volume Control	24	105	192	Stereo	Normal, I ² S	+5	SSOP-16	\$1.00
PCM1742K	Low-Cost Audio DAC w/Volume Control	24	105	192	Stereo	Normal, I ² S	+3.3 and +5.5	SSOP-16	\$1.80
PCM1608K	CMOS, Multilevel ΔΣ DAC	24	105	192	8Ch	Normal, I ² S	+3.3 and +5	LQFP-48	\$4.75
PCM1605	CMOS, Multilevel ΔΣ DAC	24	105	192	6Ch	Normal, I ² S	+3.3 and +5	MQFP-48	\$5.45
PCM1604	CMOS, Multilevel ΔΣ DAC	24	105	192	6Ch	Normal, I ² S	+3.3 and +5	LQFP-48	\$4.60
PCM1602K	Low Cost, CMOS, Multilevel ΔΣ DAC	24	105	192	6Ch	Normal, I ² S	+3.3 and +5	LQFP-48	\$3.55
PCM1748K	Low Cost, Audio DAC w/Volume Control	24	105	96	Stereo	Normal, I ² S	+3.3 and +5	SSOP-16	\$1.30
PCM1601	CMOS, Multilevel ΔΣ DAC	24	105	96	6Ch	Normal, I ² S	+3.3 and +5	MQFP-48	\$4.95
PCM1600	CMOS, Multilevel ΔΣ DAC	24	105	96	6Ch	Normal, I ² S	+3.3 and +5	LQFP-48	\$4.15
PCM1680	Low-Cost, 8Ch Audio DAC	24	103	192	8Ch	Normal, I ² S	+5	SSOP-24	\$1.50
PCM1606	Low Cost, CMOS, Multilevel ΔΣ DAC	24	103	192	6Ch	Normal, I ² S	+5	SSOP-20	\$2.00
PCM1742	Low-Cost Audio DAC w/Volume Control	24	100	192	Stereo	Normal, I ² S	+3.3 and +5	SSOP-16	\$1.65
PCM1608	Highly Integrated, 8Ch Audio DAC	24	100	192	8Ch	Normal, I ² S	+3.3 and +5	LQFP-48	\$4.30
PCM1602	Low Cost, CMOS, Multilevel ΔΣ DAC	24	100	192	6Ch	Normal, I ² S	+3.3 and +5	LQFP-48	\$3.25
PCM1748	Low Cost, Audio DAC w/Volume Control	24	100	96	Stereo	Normal, I ² S	+3.3 and +5	SSOP-16	\$1.20
TLV320DAC23	Low-Power DAC w/Headphone Amp	24	100	96	Stereo	Normal, I ² S	+1.5 and +3.3	SSOP-28	\$2.00
PCM1741	Low Cost, Audio DAC w/Volume Control	24	98	96	Stereo	Normal, I ² S	+3.3	SSOP-16	\$1.55
PCM1770/1	Low-Power DAC w/Headphone Amp	24	98	48	N/A	I ² S	+1.6 and +3.3	TSSOP-16, VQFN-20	\$1.90
PCM1772/3	Low-Power DAC w/Line Amp	24	98	48	N/A	I ² S	+1.6 and +3.6	TSSOP-16, VQFN-20	\$1.90
TLV320DAC26	Low-Power DAC w/HP/Spkr Amp	24	97	53	Stereo	Normal, I ² S	+1.8 and +3.6	QFN-32	\$2.95
PCM1720	CMOS, Multilevel ΔΣ w/Volume Control	24	96	96	Stereo	Normal, I ² S	+5	SSOP-20	\$1.95
PCM1744	Low Cost Audio DAC	24	95	96	Stereo	I ² S	+5	SO-14	\$1.35
PCM1723	w/Int. PLL, Generate DAD/MPEG Clocks	24	94	96	Stereo	Normal, I ² S	+5	SSOP-24	\$2.35
PCM1740	DAC w/Internal V _{COX} and PLL	24	94	96	Stereo	Normal, I ² S	+5	SSOP-24	\$3.15
PCM1727	DAC w/Int. Dual PLL	24	92	96	Stereo	Normal, I ² S	+5	SSOP-24	\$3.15
PCM1702P/U	BiCMOS, Sign Magnitude DAC	20	110	768	Mono	Serial Latched	±5	DIP-16, SOP-20	\$12.40
PCM1710	CMOS, Multilevel ΔΣ DAC	20	110	48	Stereo	Normal, I ² S	±5	SOIC-28	\$4.20
PCM1717/18	Stereo Audio DAC w/Wide Supply Range	18	96	48	Stereo	Normal, I ² S	+2.7 and +5.5	SSOP-20	\$3.35
PCM1719	Stereo Audio DAC w/Headphone Amplifier	18	96	48	Stereo	Normal, I ² S	+5	SSOP-28	\$5.25
PCM1733	Low-Cost Audio DAC	18	95	96	Stereo	Normal, I ² S	+5	SO-14	\$1.35
PCM1725	Low-Cost Audio DAC	16	95	96	Stereo	Normal, I ² S	+5	SO-14	\$1.30
DSD1700	Mono Channel DSD DAC	—	110	—	Mono	DSD	+5	SSOP-28	\$12.55

¹Suggested price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.

Audio Data Converters and Support Products



Audio DACs and ADCs Selection Guide (Continued)

Device	Description	Resolution (Bits) (max)	Dynamic Range (dB)	Sampling Rate (kHz) (max)	Config.	Audio Data Format	Power Supply (V)	Package(s)	Price ¹
ADCs									
PCM4204	High-Performance, 4-Channel Audio ADC	24	118	216	4Ch	Normal, I ² S, DSD, TDM	+3.3 and +5	TQFP-64	\$14.95
PCM4202	High-Performance, Stereo Audio ADC	24	118	216	Stereo	Normal, I ² S, DSD	+3.3 and +5	SSOP-28	\$7.95
PCM4201	Single-Channel, Low-Power ADC	24	112	96	1Ch	Normal, I ² S	+3.3 and +5	TSSOP-16	\$3.50
PCM1804	$\Delta\Sigma$ Audio ADC	24	112	192	Stereo	Normal, I ² S, DSD	+3.3 and +5	SSOP-28	\$5.20
PCM1850	Stereo Audio ADC with 2 x 6 Input MUX	24	100	96	Stereo	Normal, I ² S	+3.3 and +5	TQFP-32	\$4.80
PCM1802	$\Delta\Sigma$ Audio ADC	24	100	96	Stereo	Normal, I ² S	+3.3 and +5	SSOP-20	\$3.35
PCM1800	CMOS, Multilevel $\Delta\Sigma$	20	95	48	Stereo	Normal, I ² S	+5	SSOP-24	\$2.60
PCM1801	Low-Cost Audio ADC	16	93	48	Stereo	Normal, I ² S	+5	SO-14	\$2.40
Codecs									
PCM3010	Audio Stereo Codec	24	103	96/192	Stereo	Left Justified, I ² S Right Justified	+3.3 and +5	SSOP-24	\$4.00
TLV320AIC32	Low-Power Stereo Codec with Headphone/Speaker Amp	24	103	96	Stereo	Normal, I ² S, DSP, TDM	+2.7 to 3.6	QFN-32	\$3.45
TLV320AIC33	Low-Power Stereo Codec with Headphone/Speaker Amp	24	103	96	Stereo	Normal, I ² S, DSP, TDM	+2.7 to 3.6	QFN-48 BGA-80	\$3.95
PCM3052A	High-Performance Stereo Codec with Mic Preamp, MUX, Volume Control	24	100	96	Stereo	I ² S	+3.3 and +5	VQFN-32	—
TLV320AIC23B	Low-Power Codec with Headphone Amp	24	100	96	Stereo	Left Justified, I ² S Right Justified	+1.5 to 3.3	SSOP-28	\$3.15
TLV320AIC26	Low-Power, Low-Cost Codec with Headphone/Speaker Amp	24	97	53	Mono/Stereo	Left Justified, I ² S, Right Justified, DSP	+2.7 to 3.6	QFN-32	\$3.25
TLV320AIC28	Low-Power Codec with Headphone/Speaker Amp	24	95	53	Mono/Stereo	Left Justified, I ² S, Right Justified, DSP	3.0 to 3.6	QFN-48	\$3.95
TSC2101	Low-Power Codec with HP/Speaker Amp & Touch-Screen Controller	24	97	53	Mono/Stereo	Left Justified, I ² S, Right Justified, DSP	+3.0 to 3.6	TSSOP-32	\$4.95
TSC2100	Low-Power, Low-Cost Codec, Amp & Touch-Screen Controller	24	97	53	Mono/Stereo	Left Justified, I ² S, Right Justified, DSP	+2.7 to 3.6	QFN-32, TSSOP-32	\$3.95
TSC2102	Low-Power, Low-Cost DAC, Amp & Touch-Screen Controller	24	97	53	Stereo	Left Justified, I ² S, Right Justified, DSP	+2.7 to 3.6	QFN-32	\$3.70
PCM3002/03	Low-Power Codec	20	94	48	Stereo	Normal, I ² S	+2.7 to 3.6	SSOP-24	\$3.45
TSC2301	Low-Power Codec with Headphone Amp & Touch-Screen Controller	20	98	48	Stereo	Normal, I ² S	+2.7 to 3.6	TQFP-64, BGA-120	\$4.95
TSC2302	Low-Power Codec w/Headphone Amp, Keypad & Touch-Screen Controller	20	98	48	Stereo	Normal, I ² S	+2.7 to 3.6	QFN-48	\$4.50
PCM3000/1	Stereo Audio Codec	18	96	48	Stereo	Normal, I ² S	+5	SSOP-28	\$3.45
PCM3008	Low-Power, Low-Cost Codec	16	88	48	Stereo	Normal, I ² S	+2.1 to 3.6	SSOP-16	\$3.10
PCM3006	Stereo Audio Codec	16	93	48	Stereo	Normal	+2.7 to 3.6	SSOP-24	\$3.45
PCM3500/1	Voice/Modem Mono Codec	16	88	26	Mono	DSP	+2.7 to 3.6	SSOP-24	\$2.65

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in **bold red**. Preview products appear in **bold blue**.

→ Audio Data Converters and Support Products

Audio Support Products Selection Guide

Device	Description	Resolution (Bits) (max)	Dynamic Range (dB)	Sampling Rate (kHz) (max)	Config.	Audio Data Format	Power Supply (V)	Package	Price ¹
Digital Filters									
DF1704	Digital Interpolation Filter	24	N/A	96	Stereo	Normal, I ² S	+5	SSOP-28	\$10.07
DF1706	Digital Interpolation Filter	24	N/A	192	Stereo	Normal, I ² S	+3.3	SSOP-28	\$11.08
PLLs									
PLL1700	Multi-Clock Generator	—	150	96	—	—	+3.3 or +5	SSOP-20	\$1.97
PLL1705	Dual PLL Multi-Clock Generator	—	50	96	—	Parallel Control	+3.3	SSOP-20	\$1.20
PLL1706	Dual PLL Multi-Clock Generator	—	50	96	—	Serial Control	+3.3	SSOP-20	\$1.20

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Digital Audio Interface Products and Asynchronous Sample Rate Converters

Device	Description	Dynamic Range (dB)	THD+N (dB)	Input/Output Sampling Rate (kHz) max	Control Mode	Audio Data Format	Power Supply (V)	Package	Price ¹
Asynchronous Sample Rate Converters (ASRC)									
SRC4194	Highest-Performance 4-Channel ASRC	144	-140	212	S/W (SPI), H/W	Normal, I ² S, TDM	+1.8 or +3.3	TQFP-64	\$14.95
SRC4193	Highest-Performance Stereo ASRC	144	-140	212	S/W (SPI)	Normal, I ² S, TDM	+3.3	SSOP-28	\$8.50
SRC4192	Highest-Performance Stereo ASRC	144	-140	212	H/W	Normal, I ² S, TDM	+3.3	SSOP-28	\$8.50
SRC4184	4-Channel ASRC	128	-125	212	S/W (SPI), H/W	Normal, I ² S, TDM	+1.8 or +3.3	TQFP-64	\$8.50
SRC4190	Stereo ASRC	128	-125	212	H/W	Normal, I ² S, TDM	+3.3	SSOP-28	\$4.50
Digital Interface									
DIT4096	Digital Audio Interface Transmitter	—	—	96	S/W (SPI), H/W	AES/EBU, S/PDIF	+3.3 and +5	TSSOP-28	\$1.55
DIT4192	Digital Audio Interface Transmitter	—	—	192	S/W (SPI), H/W	AES/EBU, S/PDIF	+3.3 and +5	TSSOP-28	\$2.05

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in **bold red**.

Temperature Sensors

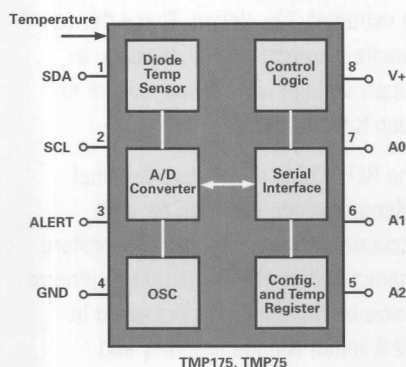
Digital Temperature Sensors

TI's low-cost, digital temperature sensors are specified for operation from -40°C to $+125^{\circ}\text{C}$ and are designed for thermal measurement in a variety of communication, computer, consumer, industrial and instrumentation applications. These silicon-based temperature sensors are designed on a unique topology that offers excellent accuracy and linearity over temperature.

Low power and standard communication protocol pair nicely with low-power microcontrollers. The digital temperature output of the TMP family is created using a high-performance, 12-bit $\Delta\Sigma$ ADC that outputs temperatures as a digital word. Programming and communication with the TMP1xx family of devices is done via a 2-wire or SPI interface for easy integration into existing digital systems.

Temperature Sensor Core

A typical block diagram of the TMP family of digital temperature sensors is shown below. Temperature is sensed through the die flag of the lead frame where the temperature sensing element is the chip itself, ensuring the most accurate temperature information of the monitored area and allowing designers to respond quickly to over and under thermal conditions.



Typical block diagram of the TMP family of digital temperature sensors.

Features of TMP Digital Temperature Sensors

Several of the TMP digital sensors offer programmable features including over and under temperature thresholds, alarm functions and temperature resolution. With extremely low power consumption ($50\mu\text{A}$) and power down standby features the TMP12x family offers as low as 1.5°C minimum of accuracy in a SOT23 package and is an excellent candidate for low-power thermal monitoring applications.

Temperature Sensors Selection Guide

Device	Description	Interface	Accuracy Over Temp Range ($^{\circ}\text{C}$) (max)	Temp Resolution (Bits) (max)	Temp Resolution (Bits) (min)	Temp Range ($^{\circ}\text{C}$) (min)	Temp Range ($^{\circ}\text{C}$) (max)	Supply Voltage (V) (min)	Voltage (V) (max)	I_0 (typ) (μA)	Price ¹
TMP100	Digital Temp Sensor	I ² C, SMBus	3	12	9	-55	125	2.7	5.5	45	\$0.75
TMP101	Digital Temp Sensor with Prog., Thermostat/Alarm Function	I ² C, SMBus	3	12	9	-55	125	2.7	5.5	45	\$0.80
TMP121	1.5 $^{\circ}\text{C}$ Accurate Digital Temp Sensor with SPI Interface	SPI	2	12	12	-40	125	2.7	5.5	35	\$0.90
TMP122	1.5 $^{\circ}\text{C}$ Accurate Programmable Temp Sensor with SPI Interface	SPI	2	12	9	-40	125	2.7	5.5	50	\$0.99
TMP123	1.5 $^{\circ}\text{C}$ Accurate Digital Temp Sensor with SPI Interface	SPI	2	12	12	-55	125	2.7	5.5	35	\$0.90
TMP124	1.5 $^{\circ}\text{C}$ Accurate Prog. Digital Temp Sensor w/SPI Interface	SPI	2	12	9	-40	125	2.7	5.5	50	\$0.70
TMP125	2 $^{\circ}\text{C}$ Accurate Digital Temp. Sensor with SPI Interface	SPI	2.5	10	10	-40	125	2.7	5.5	36	\$0.80
TMP175	Digital Temp Sensor with 2-Wire Interface	I ² C, SMBus	1.5	12	9	-40	125	2.7	5.5	50	\$0.85
TMP75	Digital Temp Sensor with 2-Wire Interface	I ² C, SMBus	2	12	9	-40	125	2.7	5.5	50	\$0.70
TMP141	Digital Temp Sensor with Single-Wave Sensor Path™ Bus	Single-Wire Sensor Path	3	10	10	-40	125	2.7	5.5	110	\$0.65
Device	Description	Output	Accuracy ($^{\circ}\text{C}$) (max)	Output (mV/ $^{\circ}\text{C}$)	Temp Range ($^{\circ}\text{C}$) (min)	Temp Range ($^{\circ}\text{C}$) (max)	Voltage (V) (min)	Voltage (V) (max)	I_0 (typ) (μA)	Package	Price ¹
TMP300	Analog Temperature Switch	Open-Drain	± 3	10	-40	150	1.8	18	100	SC-70	\$0.70

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in bold red. Preview products are listed in bold blue.



Voltage References

Precision Voltage and Current References

TI's family of voltage and current references incorporates state-of-the-art technology to offer stable, high-precision, high-performance references in tiny packages.

Series Voltage References

Series voltage references are known for excellent accuracy and stability over temperature. Typically three terminal devices, series voltage references are often used to provide stable reference voltages for ADCs and microcontrollers.

The REF29xx, REF30xx, REF31xx and REF32xx are TI's newest available families of precision, low-power, low-dropout, series voltage references in tiny SOT23-3 packages. Drift specifications range from 100ppm/°C to less than 10ppm/°C. Small size and low power

consumption (100µA typ) make them ideal for portable and battery-powered applications. These voltage references are stable with any capacitive load and can sink/source a minimum of up to 10mA of output current and are specified for the temperature range of -40°C to +125°C.

Shunt Voltage References

Shunt voltage references are precision diodes designed to offer good accuracy at extremely low power. These devices require a current source, typically a supply voltage and pull-up resistor to keep forward biased.

The REF1112 is a 1µA, two-terminal reference diode designed for high accuracy with outstanding temperature characteristics at low operating currents. Precision thin-film resistors result in 0.2% initial voltage accuracy and 50ppm/°C maximum temperature drift.

The REF1112 is specified from -40°C to +85°C, with operation from 1µA to 5mA, and is offered in a SOT23-3 package.

Current References

Many applications require the use of a precision current source or current sink. The REF200 combines three circuit building-blocks on a single monolithic chip—two 100µA current sources and a current mirror capable of being used as a current source or sink.

Integrated Op Amp and Voltage References

For applications requiring an op amp plus voltage reference or comparator plus voltage reference, TI has an offering of integrated function voltage references. The TLV3011 and TLV3012 are low-power, (5µA) 6µs propagation delay comparators with an integrated shunt voltage reference.

Voltage References Selection Guide

Device	Description	Output (V)	Initial Accuracy (%) (max)	Drift (ppm/°C) (max)	Long-Term Stability (ppm/1000hr) (typ)	Noise 0.1 to 10Hz (µVp-p) (typ)	I _Q (mA) (max)	Temperature Range (°C)	Output Current (mA)	Package(s)	Price ¹
REF32xx	Precision, Micropower	1.25, 2.048, 2.5 3.0, 3.3, 4.096	0.10	7	24	15 to 30	0.1	-40 to +125	±10	SOT23-6	\$1.85
REF31xx	Precision, Micropower	1.25, 2.048, 2.5 3.0, 3.3, 4.096	0.2	15	24	15 to 30	0.1	-40 to +125	±10	SOT23-3	\$1.10
REF30xx	Micropower, Bandgap	1.25, 2.048, 2.5, 3.0, 3.3, 4.096	0.2	50	24	20 to 45	0.05	-40 to +125	25	SOT23-3	\$0.59
REF29xx	Micropower, Bandgap	1.25, 2.048, 2.5, 3.0, 3.3, 4.096	2	100	24	20 to 45	0.05	-40 to +125	25	SOT23-3	\$0.49
REF02A	Low Drift, Low Noise, Buried Zener	5	0.19	15	50	4	1.4	-25 to +85	+21, -0.5	PDIP-8, SOIC-8	\$1.65
REF02B	Low Drift, Low Noise, Buried Zener	5	0.13	10	50	4	1.4	-25 to +85	+21, -0.5	PDIP-8, SOIC-8	\$2.27
REF102A	Low Drift, Low Noise, Buried Zener	10	0.1	10	20	5	1.4	-25 to +85	+10, -5	PDIP-8, SOIC-8	\$1.65
REF102B	Low Drift, Low Noise, Buried Zener	10	0.05	5	20	5	1.4	-25 to +85	+10, -5	PDIP-8, SOIC-8	\$4.15
REF102C	Ultra-Low Drift, Low Noise, Buried Zener	10	0.025	2.5	20	5	1.4	-25 to +85	+10, -5	PDIP-8, SOIC-8	\$4.85
Shunt											
REF1112	NanoPower 1.25V Shunt	1.25	0.2	30	60	25	0.0012	-40 to +125	1A to 5mA	SOT-23	\$0.85
Current Reference											
REF200	Dual Current Reference with Current Mirror	Two 100µA	±1µA	25 (typ)	—	1µAp-p	—	-25 to +85	50µA to 400µA	PDIP-8, SOIC-8	\$2.60

¹Suggested resale price in U.S. dollars in quantities of 1,000.

New products are listed in **bold red**. Preview products are listed in **bold blue**.

ADC Selection Guide

Device	Res. (Bits)	Sample Rate (kSPS)	Architecture	No. of Input Channels	SINAD (dB)	SNR (dB)	SFDR (dB)	DNL (\pm LSB)	INL (%)	NMC	V _{REF}	Interface	No. of Supplies	Analog Supply	Logic Supply	Power (mW)	Price ¹	Refer to Page
ADS1258	24	125	Delta-Sigma	16 SE/8 Diff	—	—	—	1	0.0015	24	Ext	Serial	2	4.75, 5.25	1.8, 3.6	40	\$8.95	52
ADS1271	24	105	Delta-Sigma	1 Diff	103	110	105	1	0.0015	24	Ext	Serial, SPI	2	4.75, 5.25	2.5, 3.6	50 - 100	\$5.95	50, 52, 75
ADS1252	24	41	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.0015	24	Ext	Serial	1	4.75, 5.25	4.75, 5.25	40	\$5.60	52, 75
ADS1255	24	30	Delta-Sigma	2 SE/1 Diff	—	—	—	1	0.0010	24	Ext	Serial, SPI	2	4.75, 5.25	1.8, 3.6	35	\$8.25	51, 52
ADS1256	24	30	Delta-Sigma	8 SE/4 Diff	—	—	—	1	0.001	24	Ext	Serial, SPI	2	4.75, 5.25	1.8, 3.6	35	\$8.95	51, 52
ADS1251	24	20	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.0015	24	Ext	Serial	1	4.75, 5.25	4.75, 5.25	7.5	\$5.60	52, 75
ADS1253	24	20	Delta-Sigma	4 SE/4 Diff	—	—	—	1	0.0015	24	Ext	Serial	1	4.75, 5.25	4.75, 5.25	7.5	\$6.70	52, 75
ADS1254	24	20	Delta-Sigma	4 SE/4 Diff	—	—	—	1	0.0015	24	Ext	Serial	2	4.75, 5.25	1.8, 3.6	4	\$6.70	52, 75
ADS1210	24	16	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.0015	24	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	27.5	\$10.25	52
ADS1211	24	16	Delta-Sigma	4 SE/4 Diff	—	—	—	1	0.0015	24	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	27.5	\$10.90	52
ADS1216	24	0.78	Delta-Sigma	8 SE/8 Diff	—	—	—	1	0.0015	24	Int/Ext	Serial, SPI	2	2.7, 5.25	2.7, 5.25	0.6	\$5.00	52, 75, 79
ADS1217	24	0.78	Delta-Sigma	8 SE/8 Diff	—	—	—	1	0.0012	24	Int/Ext	Serial, SPI	2	2.7, 5.25	2.7, 5.25	0.8	\$5.00	52, 75, 79
ADS1218	24	0.78	Delta-Sigma	8 SE/8 Diff	—	—	—	1	0.0015	24	Int/Ext	Serial, SPI	2	2.7, 5.25	2.7, 5.25	0.8	\$5.50	52, 75, 79
ADS1224	24	0.24	Delta-Sigma	4 SE/4 Diff	—	—	—	1	0.0015	24	Ext	Serial	2	2.7, 5.5	2.7, 5.5	0.5	\$3.25	50, 52
ADS1222	24	0.24	Delta-Sigma	2 SE/2 Diff	—	—	—	1	0.0015	24	Ext	Serial	2	2.7, 5.25	2.7, 5.25	0.5	\$2.95	50, 52
ADS1234	24	0.08	Delta-Sigma	4 SE/4 Diff	—	—	—	1	0.0015	24	Ext	Serial	2	2.7, 5.25	2.7, 5.25	3	\$4.80	52
ADS1232	24	0.08	Delta-Sigma	2 SE/2 Diff	—	—	—	1	0.0015	24	Ext	Serial	2	2.7, 5.25	2.7, 5.25	3	\$3.50	52
ADS1244	24	0.015	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.0008	24	Ext	Serial	2	2.5, 5.25	1.8, 3.6	0.3	\$2.95	52
ADS1245	24	0.015	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.0015	24	Ext	Serial	2	2.5, 5.25	1.8, 3.6	0.5	\$3.10	52
ADS1240	24	0.015	Delta-Sigma	4 SE/2 Diff	—	—	—	1	0.0015	24	Ext	Serial, SPI	2	2.7, 5.25	2.7, 5.25	0.6	\$3.80	52, 75
ADS1241	24	0.015	Delta-Sigma	8 SE/4 Diff	—	—	—	1	0.0015	24	Ext	Serial, SPI	2	2.7, 5.25	2.7, 5.25	0.5	\$4.20	52, 75
ADS1242	24	0.015	Delta-Sigma	4 SE/2 Diff	—	—	—	1	0.0015	24	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	0.6	\$3.60	52
ADS1243	24	0.015	Delta-Sigma	8 SE/4 Diff	—	—	—	1	0.0015	24	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	0.6	\$3.95	52
ADS1212	22	6.25	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.0015	22	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	1.4	\$7.70	52
ADS1213	22	6.25	Delta-Sigma	4 SE/4 Diff	—	—	—	1	0.0015	22	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	1.4	\$9.00	52
ADS1250	20	25	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.003	20	Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	75	\$6.95	52
DDC101	20	15	Delta-Sigma	1 IN	—	—	—	1	0.025	20	Ext	Serial	2	4.75, 5.25	4.75, 5.25	80	\$23.00	52
DDC112	20	3	Delta-Sigma	2 SE, 1 IN	—	—	—	1	0.025	20	Ext	Serial	2	4.75, 5.25	4.75, 5.25	80	\$12.10	52
DDC114	20	2.5	Delta-Sigma	4 SE, 1 IN	—	—	—	1	0.025	20	Ext	Serial	2	4.75, 5.0	2.7, 5.25	55	\$18.00	52
DDC118	20	3	Delta-Sigma	8	—	—	—	1	0.025	20	Ext	Serial	2	4.75, 5.0	2.7, 5.25	110	\$32.00	52
ADS1625	18	1.25MSPS	Delta-Sigma	1 Diff	91	93	103	1	0.0015	18	Int/Ext	P18	2	4.75, 5.25	2.7, 5.25	520	\$37.60	52, 75
ADS1626	18	1.25MSPS	Delta-Sigma	1 Diff	91	93	103	1	0.0015	18	Int/Ext	P18 w/FIFO	2	4.75, 5.25	4.75, 5.25	520	\$39.60	52, 75
ADS8381	18	580	SAR	1 SE	88	88	112	2.5	0.0018	18	Ext	P8/P16/P18	2	4.75, 5.25	2.7, 5.25	100	\$16.65	55, 75
ADS8380	18	580	SAR	1 SE	90	91	112	-1/+2	0.0018	18	Int/Ext	Serial, SPI	1	4.75, 5.25	2.7, 5.75	100	\$16.50	55
ADS8382	18	580	SAR	1 Diff	95	96	112	-1/+2	0.0018	18	Int/Ext	Serial, SPI	1	4.75, 5.25	2.7, 5.75	100	\$16.95	55
ADS8383	18	500	SAR	1 SE	85	87	112	2.5	0.006	18	Ext	P8/P16/P18	2	4.75, 5.25	2.95, 5.25	110	\$15.75	55, 75
ADS1610	16	10MSPS	Parallel	1 Diff	83	84	96	0.5	0.005	16	Int/Ext	P16	2	4.75, 5.25	2.7, 5.25	1000	\$40.00	52
ADS1605	16	5MSPS	Delta-Sigma	1 Diff	86	88	101	0.25	0.0015	16	Int/Ext	P16	2	4.75, 5.25	2.7, 5.25	570	\$32.05	52, 75
ADS1606	16	5MSPS	Delta-Sigma	1 Diff	86	88	101	0.25	0.0015	16	Int/Ext	P16 w/FIFO	2	4.75, 5.25	4.75, 5.25	570	\$33.70	52, 75
ADS1602	16	2.5MSPS	Delta-Sigma	1 Diff	86	88	101	0.25	0.0015	16	Int/Ext	Serial	2	4.75, 5.25	2.7, 5.25	550	\$23.00	51, 52, 75

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ADC Selection Guide (Continued)

Device	Res. (Bits)	Sample Rate (kSPS)	Architecture	No. of Input Channels	SINAD (dB)	SNR (dB)	SFDR (dB)	DNL (\pm LSB)	INL (%)	NMC	V _{REF}	Interface	No. of Supplies	Analog Supply	Logic Supply	Power (mW)	Price ¹	Refer to Page #
ADS8411	16	2MSPS	SAR	1 SE	87	86	100	2	0.00375	16	Int	P8/P16	2	4.75, 5.25	2.95, 5.25	155	\$22.00	55, 75
ADS8412	16	2MSPS	SAR	1 Diff	90	90	100	2	0.00375	16	Int	P8/P16	2	4.75, 5.25	2.95, 5.25	155	\$23.05	55, 75
ADS8401	16	1.25MSPS	SAR	1 SE	85	86	100	2	0.00375	16	Int	P8/P16	2	4.75, 5.25	2.95, 5.25	155	\$12.55	55, 75
ADS8402	16	1.25MSPS	SAR	1 Diff	88	90	100	2	0.00375	16	Int	P8/P16	2	4.75, 5.25	2.95, 5.25	155	\$13.15	55, 75
ADS1601	16	1.25MSPS	Delta-Sigma	1 Diff	86	88	101	0.25	0.0015	16	Int/Ext	Serial	2	4.75, 5.25	2.7, 5.25	350	\$14.00	52, 75
ADS8405	16	1.25MSPS	SAR	1 SE, 1 PDiff	85	86	105	-1, +1.5	0.003	16	Int/Ext	P8/P16	2	4.75, 5.25	2.7, 5.25	155	\$14.10	55
ADS8406	16	1.25MSPS	SAR	1 Diff	90	91	105	-1, +1.5	0.003	16	Int/Ext	P8/P16	2	4.75, 5.25	2.7, 5.25	155	\$14.70	55
ADS8371	16	750	SAR	1 SE	87	87	100	2	0.0022	16	Ext	P8/P16	2	4.75, 5.25	2.95, 5.25	110	\$12.00	55
ADS8370	16	600	SAR	1 SE, 1 PDiff	90	90	109	-1, +1.5	0.0015	16	Int/Ext	Serial, SPI	2	4.75, 5.25	2.7, 5.25	110	\$12.50	54, 55
ADS8372	16	600	SAR	1 Diff	94	94	109	1	0.0012	16	Int/Ext	Serial, SPI	2	4.75, 5.25	2.7, 5.25	110	\$13.00	54, 55
ADS8322	16	500	SAR	1 Diff	83	—	96	2	0.009	15	Int/Ext	P8/P16	1	4.75, 5.25	4.75, 5.25	85	\$7.10	55, 75
ADS8323	16	500	SAR	1 Diff	83	—	94	2	0.009	15	Int/Ext	P8/P16	1	4.75, 5.25	4.75, 5.25	85	\$7.10	55, 75
ADS8361	16	500	SAR	2 x 2 Diff	83	83	94	1.5	0.00375	14	Int/Ext	Serial, SPI	2	4.75, 5.25	2.7, 5.5	150	\$10.35	55, 75, 79
ADS8509	16	250	SAR	1 SE	86	88	100	1	0.005	16	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	70	\$12.95	54, 55
ADS8342	16	250	SAR	4 Diff	85	87	92	2	0.006	16	Ext	P8/P16	2	4.75, 5.25	2.7, 5.5	200	\$11.30	55
ADS7811	16	250	SAR	1 SE	87	87	100	2	0.006	15	Int/Ext	P16	2	4.75, 5.25	4.75, 5.25	200	\$36.15	55
ADS7815	16	250	SAR	1 SE	84	84	100	2	0.006	15	Int/Ext	P16	2	4.75, 5.25	4.75, 5.25	200	\$21.30	55
ADS8364	16	250	SAR	1 x 6 Diff	82.5	83	94	1.5	0.0045	14	Int/Ext	P16	1	4.75, 5.25	4.75, 5.25	413	\$18.10	55, 75, 79
TLC4541	16	200	SAR	1 SE	84.5	85	95	2	0.0045	16	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	17.5	\$6.85	55, 76
TLC4545	16	200	SAR	1 Diff	84.5	85	95	2	0.0045	16	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	17.5	\$6.85	55, 76
ADS7805	16	100	SAR	1 SE	86	86	94	1	0.0045	16	Int/Ext	P8/P16	1	4.75, 5.25	4.75, 5.25	81.5	\$21.80	55
ADS7809	16	100	SAR	1 SE	88	88	100	1	0.0045	16	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	81.5	\$21.80	55
ADS8320	16	100	SAR	1 Diff	84	92	86	2	0.012	15	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	1.95	\$5.15	55, 75
ADS8321	16	100	SAR	1 Diff	84	87	86	2	0.012	15	Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	5.5	\$5.15	55, 75
ADS8325	16	100	SAR	1 Diff	91	91	108	2	0.006	16	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	2.25	\$5.90	55, 75
ADS8341	16	100	SAR	4 SE 2 Diff	86	—	92	2	0.006	15	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	3.6	\$7.40	55
ADS8343	16	100	SAR	4 SE 2 Diff	86	—	97	2	0.006	15	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	3.6	\$7.45	55
ADS8344	16	100	SAR	8 SE 4 Diff	86	—	92	2	0.006	15	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	3.6	\$8.00	55
ADS8345	16	100	SAR	8 SE 4 Diff	85	—	98	2	0.006	15	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	3.6	\$8.00	55
ADS7807	16	40	SAR	1 SE	88	88	100	1.5	0.0022	16	Int/Ext	Serial, SPI/P8	1	4.75, 5.25	4.75, 5.25	28	\$27.40	55
ADS7813	16	40	SAR	1 SE	89	89	102	1	0.003	16	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	35	\$21.30	55
ADS7825	16	40	SAR	4 SE	83	86	90	1	0.003	16	Int/Ext	Serial, SPI/P8	1	4.75, 5.25	4.75, 5.25	50	\$29.55	55
ADS1112	16	0.24	Delta-Sigma	3 SE/2 Diff	—	—	—	1	0.01	16	Int	Serial, I ² C	1	2.7, 5.5	2.7, 5.5	0.7	\$2.65	52
ADS1110	16	0.24	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.01	16	Int	Serial, I ² C	1	2.7, 5.5	2.7, 5.5	0.7	\$1.95	52
ADS1100	16	0.128	Delta-Sigma	1 SE 1 Diff	—	—	—	1	0.0125	16	Ext	Serial, I ² C	1	2.7, 5.5	2.7, 5.5	0.3	\$1.80	52
ADS1202	16	10MHz Clock	Modulator	1 SE 1 Diff	—	—	—	1	0.018	16	Int/Ext	Modulator	1	4.75, 5.25	4.75, 5.25	30	\$2.50	79
ADS1203	16	10MHz Clock	Modulator	1 SE 1 Diff	—	—	—	1	0.003	16	Int/Ext	Modulator	1	4.75, 5.25	4.75, 5.25	30	\$2.70	79
ADS1204	16	10MHz Clock	Modulator	4 SE 4 Diff	—	—	—	1	0.003	16	Int/Ext	Modulator	1	4.75, 5.25	4.75, 5.25	60	\$6.75	79
ADS1205	16	10MHz Clock	Modulator	2 Diff	88.2	88.9	98	\pm 1	0.005	16	Int/Ext	Serial	1	4.5, 5.5	2.7, 5.5	75	\$3.95	79
ADS1208	16	10MHz Clock	Modulator	1 SE/1 Diff	81.5	82	93	\pm 1	0.012	16	Int/Ext	Serial	2	4.5, 5.5	2.7, 5.5	64	\$2.95	79

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ADC Selection Guide (Continued)

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ADS5500	14	125MSPS	Pipeline	1 Diff	70	70.5	82	-0.9/+1.1	5	14	Int	P14	1	3.0, 3.6	3.0, 3.6	780	\$95.00	59, 61
ADS5541	14	105MSPS	Pipeline	1 Diff	—	71	82	—	—	14	Int	P14	1	3.0, 3.6	3.3	710	\$75.00	61
ADS5424	14	105MSPS	Pipeline	1 Diff	74	74	93	-0.95, 1.5	1.5	—	Int	P14	1	4.25, 5.25	3, 3.6	1900	\$56.00	61
ADS5542	14	80MSPS	Pipeline	1 Diff	—	72	85	—	—	14	Int	P14	1	3.0, 3.6	3.3	670	\$30.00	61
ADS5423	14	80MSPS	Pipeline	1 Diff	74	74	94	-0.95, 1.5	1.5	—	Int	P14	1	4.75, 5.25	3, 3.6	1850	\$40.00	61
ADS5553	14	65MSPS	Pipeline	2 Diff	73.4	74	84	0.6	2.5	—	Int	P14	1	3, 3.6	3, 3.6	720	\$30.00	61
ADS5422	14	62MSPS	Pipeline	1 Diff	72	72	85	1	1.5	—	Int/Ext	P14	2	4.75, 5.25	3, 5	1200	\$30.45	61
ADS5421	14	40MSPS	Pipeline	1 Diff	75	75	83	1	—	14	Int/Ext	P14	2	4.75, 5.25	3, 5	900	\$20.15	61
ADS850	14	10MSPS	Pipeline	1 SE/1 Diff	75	76	85	1	5LSB	14	Int/Ext	P14	2	4.7, 5.3	2.7, 5.3	250	\$16.80	61
THS1408	14	8MSPS	Pipeline	1 SE/1 Diff	70	72	80	1	5LSB	—	Int/Ext	P14	1	3, 3.6	3, 3.6	270	\$14.85	61, 76
ADS7891	14	3MSPS	SAR	1 SE	78	77.5	88	+1.5/-1	0.009	14	Int	P8/P14	2	4.75, 5.25	2.7, 5.25	90	\$10.50	55
THS1403	14	3MSPS	Pipeline	1 SE/1 Diff	70	72	80	1	5LSB	—	Int/Ext	P14	1	3, 3.6	3, 3.6	270	\$11.05	61, 76
THS14F03	14	3MSPS	Pipeline	1 SE/1 Diff	70	72	80	1	2.5LSB	—	Int/Ext	P14	1	3, 3.6	3, 3.6	270	\$12.60	61, 76
ADS7890	14	1.25MSPS	SAR	1 SE	78	77.5	100	+1.5/-1	0.009	14	Int	Serial, SPI	2	4.75, 5.25	2.7, 5.25	90	\$10.50	55
THS1401	14	1MSPS	Pipeline	1 SE/1 Diff	70	72	80	1	5LSB	—	Int/Ext	P14	1	3, 3.6	3, 3.6	270	\$8.90	61, 76
THS14F01	14	1MSPS	Pipeline	1 SE/1 Diff	70	72	80	1	2.5LSB	—	Int/Ext	P14	1	3, 3.6	3, 3.6	270	\$9.65	61, 76
TLC3541	14	200	SAR	1 SE	81.5	82	95	1	0.006	14	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	17.5	\$5.00	55, 76
TLC3544	14	200	SAR	4 SE/2 Diff	81	81	97	1	0.006	14	Int/Ext	Serial, SPI	2	4.5, 5.5	2.7, 5.5	20	\$6.00	55, 76
TLC3545	14	200	SAR	1 Diff	81.5	82	95	1	0.006	14	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	17.5	\$5.00	55, 76
TLC3548	14	200	SAR	8 SE/4 Diff	81	81	97	1	0.006	14	Int/Ext	Serial, SPI	2	4.5, 5.5	2.7, 5.5	20	\$6.40	55, 76
TLC3574	14	200	SAR	4 SE	79	80	84	1	0.006	14	Ext	Serial, SPI	2	4.5, 5.5	2.7, 5.5	29	\$6.85	55, 76
TLC3578	14	200	SAR	8 SE	79	80	83	1	0.006	14	Ext	Serial, SPI	2	4.5, 5.5	2.7, 5.5	29	\$8.65	55, 76
ADS8324	14	50	SAR	1 Diff	78	78	85	2	0.012	14	Ext	Serial, SPI	1	1.8, 3.6	1.8, 3.6	2.5	\$4.15	55, 75
ADS7871	14	40	MUX SAR and PGA	8 SE/4 Diff	—	—	—	2	0.03	13	Int	Serial, SPI	1	2.7, 5.25	2.7, 5.25	6	\$5.00	55, 79
TLC7135	14	0.003	Dual-Slope	1 SE/1 Diff	—	—	—	—	0.005	4.5 Dig	Ext	MUX BCD	2	4.75, 5.25	4.75, 5.25	5	\$1.95	52
ADS5520	12	125MSPS	Pipeline	1 Diff	—	69	82	—	—	12	Int	P12	1	3.0, 3.6	3.3	740	\$33.90	61
ADS5521	12	105MSPS	Pipeline	1 Diff	—	69	85	—	—	12	Int	P12	1	3.0, 3.6	3.3	700	\$29.90	61
ADS5522	12	80MSPS	Pipeline	1 Diff	—	70	82	—	—	12	Int	P12	1	3.0, 3.6	3.3	660	\$16.70	61
ADS5410	12	80MSPS	Pipeline	1 SE/1 Diff	66	65	76	1	2LSB	14	Int/Ext	P12	2	3, 3.6	1.6, 2	360	\$19.00	61
ADS809	12	80MSPS	Pipeline	1 SE/1 Diff	64	63	67	1.7	6LSB	12	Int/Ext	P12	2	4.75, 5.25	3, 5	905	\$24.95	61
ADS5273	12	70MSPS	Pipeline	8 Diff	70	70.5	85	0.9	\pm 2LSB	12	Int/Ext	LVDS	1	3.0, 3.6	3.3	1104	\$121.00	63
ADS808	12	70MSPS	Pipeline	1 SE/1 Diff	64	64	68	1.7	7LSB	12	Int/Ext	P12	2	4.75, 5.25	3, 5	720	\$19.50	61
ADS5232	12	65MSPS	Pipeline	2 Diff	—	70.7	—	0.9	0.9	2	Int	Parallel	1	3, 3.6	3, 3.6	340	\$20.00	61
ADS5221	12	65MSPS	Pipeline	1 SE/1 Diff	69	70	90	1	1.5	12	Int/Ext	P12	1	3.0, 3.6	2.5, 3.3	285	\$13.95	61
ADS5413	12	65MSPS	Pipeline	1 Diff	67.6	68.5	77.5	1	2LSB	12	Int/Ext	P12	1	3.0, 3.6	3.3	400	\$15.50	61
ADS5272	12	65MSPS	Pipeline	8 Diff	70	70.5	85	0.9	2LSB	12	Int/Ext	LVDS	1	3.0, 3.6	3.3	984	\$65.00	61
ADS5242	12	65MSPS	Pipeline	4 Diff	70	70.5	85	0.9	2LSB	12	Int/Ext	LVDS	1	3.0, 3.6	3.3	683	\$36.00	61
ADS807	12	53MSPS	Pipeline	1 SE/1 Diff	69	69	82	1	4LSB	12	Int/Ext	P12	2	4.75, 5.25	3, 5	335	\$11.30	61
ADS5271	12	50MSPS	Pipeline	8 Diff	70	70.5	85	0.9	\pm 2LSB	12	Int/Ext	LVDS	1	3.0, 3.6	3.3	936	\$50.00	61
ADS2807	12	50MSPS	Pipeline	2 SE/2 Diff	68	65	70	1	5LSB	12	Int/Ext	P12	2	4.75, 5.25	3, 5	720	\$18.05	61

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ADC Selection Guide (Continued)

Device	Res. (Bits)	Sample Rate (kSPS)	Architecture	No. of Input Channels	SINAD (dB)	SNR (dB)	SFDR (dB)	DNL (\pm LSB)	INL (%)	NMC	V _{REF}	Interface	No. of Supplies	Analog Supply	Logic Supply	Power (mW)	Price ¹	Refer to Page #
ADS5240	12	40MSPS	Pipeline	4 Diff	70	70.5	85	0.9	2	12	Int/Ext	LVDS	1	3.0, 3.6	3.3	607	\$25.00	61
ADS5270	12	40MSPS	Pipeline	8 Diff	70	70.5	85	0.9	2	12	Int/Ext	LVDS	1	3.0, 3.6	3.3	904	\$45.00	61
ADS5220	12	40MSPS	Pipeline	1 SE/1 Diff	69	70	90	1	1.5	12	Int/Ext	P12	1	3.0, 3.6	2.5, 3.3	195	\$9.85	61
ADS800	12	40MSPS	Pipeline	1 SE/1 Diff	64	62	61	1	—	12	Int/Ext	P12	1	4.75, 5.25	4.75, 5.25	390	\$30.85	61
ADS2806	12	32MSPS	Pipeline	2 SE/2 Diff	69	66	73	1	4LSB	12	Int/Ext	P12	2	4.75, 5.25	3, 5	430	\$14.10	61
THS1230	12	30MSPS	Pipeline	1 SE/1 Diff	67.4	67.7	74.6	1	2.5LSB	12	Int/Ext	P12	1	3, 3.6	3, 3.6	168	\$10.50	61
ADS801	12	25MSPS	Pipeline	1 SE/1 Diff	66	64	61	1	—	12	Int/Ext	P12	1	4.75, 5.25	4.75, 5.25	270	\$12.55	61
ADS805	12	20MSPS	Pipeline	1 SE/1 Diff	66	68	74	0.75	2LSB	12	Int/Ext	P12	2	4.75, 5.25	3, 5	300	\$9.90	61, 75
THS1215	12	15MSPS	Pipeline	1 SE/1 Diff	68.6	68.9	81.7	0.9	1.5LSB	12	Int/Ext	P12	1	3, 3.6	3, 3.6	148	\$9.85	61
ADS802	12	10MSPS	Pipeline	1 SE/1 Diff	66	66	66	1	2.75LSB	12	Int/Ext	P12	1	4.75, 5.25	4.75, 5.25	260	\$12.60	61
ADS804	12	10MSPS	Pipeline	1 SE/1 Diff	68	69	80	0.75	2LSB	12	Int/Ext	P12	2	4.7, 5.3	3, 5	180	\$9.20	61, 75
THS12082	12	8MSPS	Pipeline	2 SE/1 Diff	65	69	71	1	1.5LSB	12	Int/Ext	P12	2	4.75, 5.25	3, 5.25	186	\$8.40	61, 76
THS1209	12	8MSPS	Pipeline	2 SE/1 Diff	65	69	71	1	1.5LSB	12	Int/Ext	P12	2	4.75, 5.25	4.75, 5.25	186	\$7.90	61, 76
THS1206	12	6MSPS	Pipeline	4 SE/2 Diff	65	69	71	1	1.8LSB	12	Int/Ext	P12	2	4.75, 5.25	3, 5.25	186	\$7.80	61, 76
THS1207	12	6MSPS	Pipeline	4 SE/2 Diff	64	69	71	1	1.5LSB	12	Int/Ext	P12	2	4.75, 5.25	4.75, 5.25	186	\$7.25	61, 76
ADS803	12	5MSPS	Pipeline	1 SE/1 Diff	68	69	82	2	0.75LSB	12	Int/Ext	P12	2	4.7, 5.3	4.7, 5.3	115	\$7.03	61, 75
ADS7881	12	4MSPS	SAR	1 SE	71.5	71.5	90	1	0.024	12	Int	P8/P12	2	4.75, 5.25	2.7, 5.25	110	\$7.35	55
ADS7869	12	1MSPS	SAR	12 Diff	—	—	—	2	0.048	11	Int/Ext	Serial, SPI, P12	3	3.3, 5.5	2.7, 5.5	175	\$14.60	55, 78, 79
ADS7886	12	1MSPS	SAR	1 SE	70	71	—	± 4	0.024	12	Ext	Serial, SPI	1	2.5, 5.75	—	11	\$2.35	55
ADS7810	12	800	SAR	1 SE	71	71	82	1	0.018	12	Int/Ext	P12	2	4.75, 5.25	4.75, 5.25	225	\$27.80	55
ADS7818	12	500	SAR	1 Diff	70	72	78	1	0.024	12	Int	Serial, SPI	1	4.75, 5.25	4.75, 5.25	11	\$2.50	55
ADS7834	12	500	SAR	1 Diff	70	72	78	1	0.024	12	Int	Serial, SPI	1	4.75, 5.25	4.75, 5.25	11	\$2.45	55
ADS7835	12	500	SAR	1 Diff	72	72	78	1	0.024	12	Int	Serial, SPI	1	4.75, 5.25	4.75, 5.25	17.5	\$2.75	56
ADS7852	12	500	SAR	8 SE	72	72	74	1	0.024	12	Int/Ext	P12	1	4.75, 5.25	4.75, 5.25	13	\$3.40	56
ADS7861	12	500	SAR	2 x 2 Diff	70	71	72	1	0.024	12	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	25	\$4.05	56, 75, 79
ADS7862	12	500	SAR	2 x 2 Diff	71	71	78	1	0.024	12	Int/Ext	P12	1	4.75, 5.25	4.75, 5.25	25	\$5.70	56, 79
ADS7864	12	500	SAR	3 x 2 Diff	71	71	78	1	0.024	12	Int/Ext	P12	1	4.75, 5.25	4.75, 5.25	52.5	\$6.65	56, 79
TLC2551	12	400	SAR	1 SE	72	—	84	1	0.024	12	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	15	\$3.95	56, 76
TLC2552	12	400	SAR	2 SE	72	—	84	1	0.024	12	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	15	\$3.95	56, 76
TLC2554	12	400	SAR	4 SE	71	—	84	1	0.024	12	Int/Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	9.5	\$5.30	56, 76
TLC2555	12	400	SAR	1 Diff	72	—	84	1	0.024	12	Int	Serial, SPI	1	4.5, 5.5	4.5, 5.5	15	\$3.95	56, 76
TLC2558	12	400	SAR	8 SE	71	—	84	1	0.024	12	Int/Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	9.5	\$5.30	56, 76
ADS7800	12	333	SAR	1 SE	72	71	77	0.75	0.012	12	Int	P8/P12	3	4.75, 5.25	4.75, 5.25	135	\$30.50	56
ADS8504	12	250	SAR	1 SE	72	70	80	0.45	0.011	12	Int/Ext	P8/P12	1	4.75, 5.25	4.75, 5.25	70	\$8.90	56
ADS8508	12	250	SAR	1 SE	73	73	90	0.45	0.011	12	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	70	\$8.90	56
ADS7866	12	200	SAR	1 SE	70	71	—	± 1	0.024	12	Ext	Serial, SPI	1	1.2, 3.6	—	0.25	\$2.15	56
ADS7816	12	200	SAR	1 Diff	72	72	86	0.75	0.024	12	Ext	Serial, SPI	1	4.5, 5.25	4.75, 5.25	1.9	\$1.95	56
ADS7817	12	200	SAR	1 Diff	71	71	86	1	0.024	12	Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	2.3	\$1.95	56
ADS7841	12	200	SAR	4 SE/2 Diff	72	72	79	1	0.024	12	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	0.84	\$2.50	56, 75
ADS7842	12	200	SAR	4 SE	72	72	79	1	0.024	12	Ext	P12	1	2.7, 5.25	2.7, 5.25	0.84	\$3.10	56

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ADC Selection Guide (Continued)

Device	Res. (Bits)	Sample Rate (kSPS)	Architecture	No. of Input Channels	SINAD (dB)	SNR (dB)	SFDR (dB)	DNL (±LSB)	INL (%)	NMC	V _{REF}	Interface	No. of Supplies	Analog Supply	Logic Supply	Power (mW)	Price ¹	Refer to Page #
ADS7844	12	200	SAR	8 SE/4 Diff	72	72	78	1	0.024	12	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	0.84	\$2.90	56, 75
TLC2574	12	200	SAR	4 SE	79	80	84	0.5	0.024	12	Ext	Serial, SPI	2	4.75, 5.5	2.7, 5.5	29	\$5.30	56, 76
TLC2578	12	200	SAR	8 SE	79	80	84	0.5	0.024	12	Ext	Serial, SPI	2	4.75, 5.5	2.7, 5.5	29	\$5.80	56, 76
TLV2541	12	200	SAR	1 SE	72	—	84	1	0.024	12	Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	2.8	\$3.85	56, 76
TLV2542	12	200	SAR	2 SE	72	—	84	1	0.024	12	Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	2.8	\$3.85	56, 76
TLV2544	12	200	SAR	4 SE	70	—	84	1	0.024	12	Int/Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	3.3	\$4.20	56, 76
TLV2545	12	200	SAR	1 Diff	72	—	84	1	0.024	12	Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	2.8	\$3.85	56, 76
TLV2548	12	200	SAR	8 SE	70	—	84	1	0.024	12	Int/Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	3.3	\$4.85	56, 76
TLV2553	12	200	SAR	11 SE	—	—	—	1	0.024	12	Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	2.43	\$3.40	56, 76
TLV2556	12	200	SAR	11 SE	—	—	—	1	0.024	12	Int/Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	2.43	\$3.55	56, 76
AMC7823	12	200	1 x 8 SAR	8 SE I/O DAS	—	74	—	1	0.024	12	Int/Ext	Serial, SPI	2	2.7, 5.5	2.7, 5.5	100	\$13.50	56, 79
ADS7829	12	125	SAR	1 Diff	71	—	86	0.75	0.018	12	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	0.6	\$1.50	56
ADS7804	12	100	SAR	1 SE	72	70	80	0.45	0.011	12	Int/Ext	P8/P12	1	4.75, 5.25	4.75, 5.25	81.5	\$14.05	56
AMC7820	12	100	1 x 8 SAR and PGA	8 DAS	72	—	—	1	0.024	12	Int	Serial, SPI	2	4.75, 5.25	2.7, 5.25	40	\$9.60	56, 77, 79
ADS7808	12	100	SAR	1 SE	73	73	90	0.45	0.011	12	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	81.5	\$10.85	56
ADS7822	12	75	SAR	1 Diff	71	—	86	0.75	0.018	12	Ext	Serial, SPI	1	2.7, 5.25	2.7, 5.25	0.6	\$1.55	56
TLC2543	12	66	SAR	11 SE	—	—	—	1	0.024	12	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	5	\$4.45	56
TLV2543	12	66	SAR	11 SE	—	—	—	1	0.024	12	Ext	Serial, SPI	1	3.3, 3.6	3.3, 3.6	3.3	\$4.45	56
ADS7823	12	50	SAR	1 SE	71	72	86	1	0.024	12	Ext	Serial, I ² C	1	2.7, 5.25	2.7, 5.25	0.75	\$2.85	56
ADS7828	12	50	SAR	8 SE/4 Diff	71	72	86	1	0.024	12	Int/Ext	Serial, I ² C	1	2.7, 5.25	2.7, 5.25	0.675	\$3.35	56
ADS7870	12	50	MUX SAR and PGA	8 SE	72	—	—	—	0.06	12	Int	Serial, SPI	1	2.7, 5.25	2.7, 5.25	4.6	\$4.15	56, 79
ADS7806	12	40	SAR	1 SE	73	73	90	0.45	0.011	12	Int/Ext	Serial, SPI/P8	1	4.75, 5.25	4.75, 5.25	28	\$12.75	56
ADS7812	12	40	SAR	1 SE	74	74	98	0.5	0.012	12	Int/Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	35	\$11.80	56
ADS7824	12	40	SAR	4 SE	73	73	90	0.5	0.012	12	Int/Ext	Serial, SPI/P8	1	4.75, 5.25	4.75, 5.25	50	\$13.10	56
ADS1286	12	37	SAR	1 Diff	72	—	90	0.75	0.024	12	Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	1	\$2.80	56
ADS1000	12	0.128	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.001	12	Ext	Serial, I ² C	1	4.75, 5.25	4.75, 5.25	0.3	\$0.99	52
ADS1010	12	0.25	Delta-Sigma	1 SE/1 Diff	—	—	—	1	0.001	12	Int	Serial, I ² C	1	4.75, 5.25	4.75, 5.25	0.7	\$1.10	52
ADS1012	12	0.24	Delta-Sigma	3 SE/1 Diff	—	—	—	1	0.001	12	Int	Serial, I ² C	1	4.75, 5.25	4.75, 5.25	0.7	\$1.45	52
ADS5413-11	11	65MSPS	Pipeline	1 Diff	65	65	77	0.75	1	11	Int/Ext	Serial	2	3, 3.6	1.6, 2	400	\$14.75	61
ADS828	10	75MSPS	Pipeline	1 SE/1 Diff	57	57	68	1	3LSB	10	Int/Ext	P10	2	4.75, 5.25	3, 5	340	\$8.70	61
ADS5277	10	65MSPS	Pipeline	8 Diff	60	60.5	80	0.9	20	10	Int/Ext	P10	1	3.0, 3.6	3.3	872	\$40.00	61
ADS5102	10	65MSPS	Pipeline	1 Diff	58	57	71	1	2.5LSB	10	Int/Ext	P10	1	1.65, 2	1.65, 2	160	\$7.10	62
ADS5122	10	65MSPS	Pipeline	8 Diff	58	59	72	1	2.5	10	Int/Ext	P10	2	1.65, 2.0	1.65, 3.6	733	\$42.85	62
ADS826/823	10	60MSPS	Pipeline	1 SE/1 Diff	58	59/60	73	1	2LSB/2	10	Int/Ext	P10	2	4.75, 5.25	3, 5	295	\$8.40	62
ADS5121	10	40MSPS	Pipeline	8 Diff	59	60	74	1	1.5	10	Int/Ext	P10	2	1.65, 2.0	1.65, 3.6	500	\$38.85	62
ADS822	10	40MSPS	Pipeline	1 SE/1 Diff	59	60	65	1	2	10	Int/Ext	P10	2	4.75, 5.25	3.0, 5.0	200	\$5.25	62
ADS5103	10	40MSPS	Pipeline	1 Diff	58	58	66	0.8	1.5LSB	10	Int/Ext	P10	1	1.65, 2	1.65, 2	105	\$5.25	62
ADS5120	10	40MSPS	Pipeline	8 Diff	57	58	72	1	1.5LSB	10	Int/Ext	P10	1	1.65, 2	1.65, 2	794	\$36.15	62
ADS5203/04	10	40MSPS	Pipeline	2 SE/2 Diff	60	60.5	73	1	1.5LSB	10	Int/Ext	P10	1	3, 3.6	3, 3.6	240/275	\$9.65/\$11.05	62
ADS821	10	40MSPS	Pipeline	1 SE/1 Diff	58	58	62	1	2LSB	10	Int/Ext	P10	1	4.75, 5.25	4.75, 5.25	390	\$13.05	62

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ADC Selection Guide (Continued)

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ADS825	10	40MSPS	Pipeline	1 SE/1 Diff	59	60	65	1	2LSB	10	Int/Ext	P10	2	4.75, 5.25	3, 5	200	\$5.25	62
THS1040	10	40MSPS	Pipeline	1 SE/1 Diff	60	57	70	0.9	1.5LSB	10	Int/Ext	P10	2	3, 3.6	3, 3.6	100	\$5.10	62
THS1041	10	40MSPS	Pipeline	1 SE/1 Diff	60	57	70	1	1.5LSB	10	Int/Ext	P10	2	3, 3.6	3, 3.6	103	\$5.45	62
THS1030	10	30MSPS	Pipeline	1 SE/1 Diff	48.6	49.4	53	1	2LSB	10	Int/Ext	P10	2	3, 5.5	3, 5.5	150	\$3.75	62
THS1031	10	30MSPS	Pipeline	1 SE/1 Diff	56	49.3	52.4	1	2LSB	10	Int/Ext	P10	2	3, 5.5	3, 5.5	160	\$4.10	62
ADS820	10	20MSPS	Pipeline	1 SE/1 Diff	60	60	62	1	2LSB	10	Int/Ext	P10	1	4.75, 5.25	4.75, 5.25	200	\$6.75	62
ADS900/901	10	20MSPS	Pipeline	1 SE/1 Diff	48/50	49/53	53/49	1	—	10	Int/Ext	P10	1	2.7, 3.7	3, 3	54/49	\$3.35/\$3.40	62
THS10082	10	8MSPS	Pipeline	2 SE/1 Diff	59	61	65	1	1LSB	10	Int/Ext	P10	2	4.75, 5.25	3, 5.25	186	\$3.70	62, 75
THS1009	10	8MSPS	Pipeline	2 SE/1 Diff	59	61	65	1	1LSB	10	Int/Ext	P10	2	4.75, 5.25	4.75, 5.25	186	\$3.20	62, 75
THS10064	10	6MSPS	Pipeline	4 SE/2 Diff	59	61	65	1	1LSB	10	Int/Ext	P10	2	4.75, 5.25	3, 5.25	186	\$4.15	62, 75
THS1007	10	6MSPS	Pipeline	4 SE/2 Diff	59	61	65	1	1LSB	10	Int/Ext	P10	2	4.75, 5.25	4.75, 5.25	186	\$3.70	62, 75
TLV1562	10	2MSPS	Pipeline	4 SE/2 Diff	58	58	70.3	1.5	1.5LSB	10	Int/Ext	P10	2	2.7, 5.5	2.7, 5.5	15	\$4.15	62
TLV1570	10	1.25MSPS	SAR	8 SE	60	61	63	1	1LSB	10	Int/Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	9	\$3.80	56, 76
TLV1571	10	1.25MSPS	SAR	1 SE	60	60	63	1	1LSB	10	Ext	P10	1	2.7, 5.5	2.7, 5.5	12	\$3.70	56, 76
TLV1572	10	1.25MSPS	SAR	1 SE	60	—	62	1	1LSB	10	Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	8.1	\$3.30	56, 76
TLV1578	10	1.25MSPS	SAR	8 SE	60	60	63	1	1LSB	10	Ext	P10	1	2.7, 5.5	2.7, 5.5	12	\$3.85	57, 76
ADS7887	10	1MSPS	SAR	1 SE	61	60	—	±1	0.05	10	Ext	Serial, SPI	1	2.5, 5.25	—	11	\$1.65	57
TLC1514	10	400	SAR	4 SE/3 Diff	60	—	82	0.5	0.012	10	Int/Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	10	\$2.90	57, 76
TLC1518	10	400	SAR	8 SE/7 Diff	60	—	82	0.5	0.012	10	Int/Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	10	\$3.45	57, 76
ADS7867	10	200	SAR	1 SE	61	60	—	±1	0.05	10	Ext	Serial, SPI	1	1.2, 3.6	—	0.25	\$1.55	57
ADS7826	10	200	SAR	1 Diff	62	—	—	1	0.0048	10	Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	0.6	\$1.25	57
TLV1504	10	200	SAR	4 SE	60	—	83	0.5	0.05	10	Int/Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	3.3	\$2.65	57, 76
TLV1508	10	200	SAR	8 SE	60	—	83	0.5	0.05	10	Int/Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	3.3	\$3.15	57, 76
TLC1550	10	164	SAR	1 SE	—	—	—	0.5	0.05	10	Ext	P10	1	4.75, 5.5	4.75, 5.5	10	\$3.90	57
TLC1551	10	164	SAR	1 SE	—	—	—	1	0.1	10	Ext	P10	1	4.75, 5.5	4.75, 5.5	10	\$3.35	57
TLV1544	10	85	SAR	4 SE	—	—	—	1	0.1	10	Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	1.05	\$1.95	57
TLV1548	10	85	SAR	8 SE	—	—	—	1	0.1	10	Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	1.05	\$2.30	57
TLC1542	10	38	SAR	11 SE	—	—	—	0.5	0.05	10	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	4	\$2.50	57
TLC1543	10	38	SAR	11 SE	—	—	—	1	0.1	10	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	4	\$2.15	57
TLC1549	10	38	SAR	1 SE	—	—	—	1	0.1	10	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	4	\$1.85	57
TLC1541	10	32	SAR	11 SE	—	—	—	1	0.1	10	Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	6	\$3.20	57
ADS831	8	80MSPS	Pipeline	1 SE/1 Diff	49	49	65	1	2LSB	8	Int/Ext	P8	2	4.75, 5.25	3, 5	310	\$3.15	62
TLV5580	8	80MSPS	Pipeline	1 SE	—	44	53	1.3	1.4LSB	—	Int/Ext	P8	1	3, 3.6	3, 3.6	213	\$14.05	62
ADS830	8	60MSPS	Pipeline	1 SE/1 Diff	48	49.5	65	1	1.5LSB	8	Int/Ext	P8	2	4.75, 5.25	3, 5	215	\$2.75	62
THS0842	8	40MSPS	Pipeline	2 SE/2 Diff	—	42.7	52	2	2.2LSB	8	Int/Ext	P8	1	3, 3.6	3, 3.6	320	\$5.05	62
TLC5540	8	40MSPS	Flash	1 SE	—	44	42	1	1LSB	—	Int/Ext	P8	1	4.75, 5.25	4.75, 5.25	85	\$2.40	62
TLV5535	8	35MSPS	Pipeline	1 SE	46	46.5	58	1.3	2.4LSB	—	Int/Ext	P8	1	3, 3.6	3, 3.6	106	\$2.40	62
ADS930	8	30MSPS	Pipeline	1 SE/1 Diff	45	46	50	1	2.5LSB	8	Int	P8	2	2.7, 5.25	3, 5	168	\$2.30	62
ADS931	8	30MSPS	Pipeline	1 SE	45	48	49	1	2.5LSB	8	Ext	P8	2	2.7, 5.5	3, 5	154	\$2.20	62
TLC5510	8	20MSPS	Pipeline	1 SE	—	46	42	0.75	1LSB	—	Ext	P8	1	4.75, 5.25	4.75, 5.25	127.5	\$2.35	62

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ADC Selection Guide (Continued)

Device	Res. (Bits)	Sample Rate (kSPS)	Architecture	No. of Input Channels	SINAD (dB)	SNR (dB)	SFDR (dB)	DNL (\pm LSB)	INL (%)	NMC	V _{REF}	Interface	No. of Supplies	Analog Supply	Logic Supply	Power (mW)	Price ¹	Refer to Page #
TLC5510A	8	20MSPS	Pipeline	1 SE	—	46	42	0.75	1LSB	—	Ext	P8	1	4.75, 5.25	4.75, 5.25	150	\$2.35	62
TLV571	8	1.25MSPS	SAR	1 SE	49	49	51	0.5	0.5	8	Ext	P8	2	2.7, 5.25	2.7, 5.25	12	\$2.35	57
ADS7888	8	1MSPS	SAR	1 SE	50	—	± 0.5	—	0.1	8	Ext	Serial, SPI	1	2.5, 5.25	—	11	\$1.25	57
TLC0820A	8	392	SAR	1 SE	—	—	—	0.5	0.2	8	Ext	P8	1	4.5, 8	4.5, 8	37.5	\$1.90	57
ADS7827	8	250	SAR	1 Diff	48	—	—	1	0.2	8	Ext	Serial, SPI	1	2.7, 5.5	2.7, 5.5	0.6	\$1.00	57
ADS7868	8	200	SAR	1 SE	50	—	± 0.5	—	0.1	8	Ext	Serial, SPI	1	1.2, 3.6	—	0.25	\$1.35	57
TLC545	8	76	SAR	19 SE	—	—	—	0.5	0.2	8	Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	6	\$3.10	57
ADS7830	8	75	SAR	8 SE/4 Diff	50	50	68	0.5	0.19	8	Int/Ext	Serial, I ² C	1	2.7, 5.25	2.7, 5.25	0.675	\$1.40	57
TLV0831	8	49	SAR	1 SE	—	—	—	0.5	0.2	8	Ext	Serial, SPI	1	2.7, 3.6	2.7, 3.6	0.66	\$1.40	57
TLC548	8	45.5	SAR	1 SE	—	—	—	0.5	0.2	8	Ext	Serial, SPI	1	3, 6	3, 6	9	\$1.20	57
TLV0832	8	44.7	SAR	2 SE/1 Diff	—	—	—	0.5	0.2	8	Ext	Serial, SPI	1	2.7, 3.6	2.7, 3.6	5	\$1.40	57
TLV0834	8	41	SAR	4 SE/2 Diff	—	—	—	0.5	0.2	8	Ext	Serial, SPI	1	2.7, 3.6	2.7, 3.6	0.66	\$1.45	57
TLC541	8	40	SAR	11 SE	—	—	—	0.5	0.2	8	Ext	Serial, SPI	1	4.75, 5.5	4.5, 5.5	6	\$1.50	57
TLC549	8	40	SAR	1 SE	—	—	—	0.5	0.2	8	Ext	Serial, SPI	1	3, 6	3, 6	9	\$0.95	57
TLV0838	8	37.9	SAR	8 SE/4 Diff	—	—	—	0.5	0.2	8	Ext	Serial, SPI	1	2.7, 3.6	2.7, 3.6	0.66	\$1.45	57
TLC0831	8	31	SAR	1 Diff	—	—	—	0.4	0.2	8	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	3	\$1.40	57
TLC542	8	25	SAR	11 SE	—	—	—	0.5	0.2	8	Ext	Serial, SPI	1	4.75, 5.25	4.75, 5.25	6	\$1.50	57
TLC0832	8	22	SAR	2 SE/1 Diff	—	—	—	0.4	0.2	8	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	12.5	\$1.40	57
TLC0834	8	20	SAR	4 SE/2 Diff	—	—	—	0.4	0.2	8	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	3	\$1.45	57
TLC0838	8	20	SAR	8 SE/4 Diff	—	—	—	0.4	0.2	8	Ext	Serial, SPI	1	4.5, 5.5	4.5, 5.5	3	\$1.45	57

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DAC Selection Guide

Device	Res. (Bits)	Settling Time (μ s)	Architecture	Number of Channels	Update Rate (MSPS)	Output (V)	DNL (\pm LSB)	INL (%)	Monotonic (Bits)	Interface	V _{REF}	Supply Voltage (V)	Power (mW) (typ)	Price ¹	Refer to Page #
DAC1220	20	10000	Delta-Sigma	1	—	5	1	0.0015	20	Serial, SPI	Ext	+ 4.75 to 5.25	2.5	\$6.33	63, 76
DAC1221	16	2000	Delta-Sigma	1	—	2.5	1	0.0015	16	Serial, SPI	Ext	+ 2.7 to 3.3	1.2	\$5.01	63, 76
DAC7654	16	12	R-2R	4	—	± 2.5	1	0.0015	16	Serial, SPI	Int	\pm or + 14.25 to 15.75	18	\$21.80	65
DAC7664	16	12	R-2R	4	—	± 2.5	1	0.0015	16	P16	Int	\pm or + 14.25 to 15.75	18	\$20.75	65
DAC8544	16	10	String	4	—	+V _{REF}	1	0.0987	16	Parallel	Ext	2.75 to 5.25	2	\$9.75	64, 65
DAC712	16	10	R-2R	1	—	± 10	1	0.003	15	P16	Int	± 11.4 to 16.5	525	\$14.50	65
DAC714	16	10	R-2R	1	—	± 10	1	0.0015	16	Serial, SPI	Int	± 11.4 to 16.5	525	\$14.50	65
DAC715	16	10	R-2R	1	—	+10	1	0.003	16	P16	Int	± 11.4 to 16.5	525	\$15.85	65
DAC716	16	10	R-2R	1	—	+10	2	0.003	16	Serial, SPI	Int	± 11.4 to 16.5	525	\$15.85	65
DAC7631	16	10	R-2R	1	—	+V _{REF} , \pm V _{REF}	2	0.0015	15	Serial, SPI	Ext	\pm or + 4.75 to 5.25	1.8	\$5.85	65
DAC7632	16	10	R-2R	2	—	+V _{REF} , \pm V _{REF}	2	0.0015	15	Serial, SPI	Ext	\pm or + 4.75 to 5.25	2.5	\$10.45	65
DAC7634	16	10	R-2R	4	—	+V _{REF} , \pm V _{REF}	2	0.0015	15	Serial, SPI	Ext	\pm or + 4.75 to 5.25	7.5	\$19.95	65
DAC7641	16	10	R-2R	1	—	+V _{REF} , \pm V _{REF}	2	0.0015	15	P16	Ext	\pm or + 4.75 to 5.25	1.8	\$6.30	65
DAC7642	16	10	R-2R	2	—	+V _{REF} , \pm V _{REF}	2	0.0015	15	P16	Ext	\pm or + 4.75 to 5.25	2.5	\$10.55	65

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DAC Selection Guide (Continued)

Device	Res. (Bits)	Settling Time (μ s)	Architecture	Number of Channels	Update Rate (MSPS)	Output (V)	DNL (\pm LSB)	INL (%)	Monotonic (Bits)	Interface	V _{REF}	Supply Voltage (V)	Power (mW) (typ)	Price ¹
DAC7643	16	10	R-2R	2	—	+V _{REF} , \pm V _{REF}	2	0.0015	15	P16	Ext	\pm or + 4.75 to 5.25	2.5	\$10.55
DAC7644	16	10	R-2R	4	—	+V _{REF} , \pm V _{REF}	2	0.0015	15	P16	Ext	\pm or + 4.75 to 5.25	7.5	\$19.95
DAC7734	16	10	R-2R	4	—	+V _{REF} , \pm V _{REF}	1	0.0015	16	Serial, SPI	Ext	\pm or + 14.25 to 15.75	50	\$31.45
DAC7744	16	10	R-2R	4	—	+V _{REF} , \pm V _{REF}	1	0.0015	16	P16	Ext	\pm or + 14.25 to 15.75	50	\$31.45
DAC8501	16	10	String	1	—	+V _{REF} /MDAC	1	0.0987	16	Serial, SPI	Ext	+ 2.7 to 5.5	0.72	\$3.00
DAC8531	16	10	String	1	—	+V _{REF}	1	0.0987	16	Serial, SPI	Ext	+ 2.7 to 5.5	0.72	\$3.00
DAC8532	16	10	String	2	—	+V _{REF}	1	0.0987	16	Serial, SPI	Ext	+ 2.7 to 5.5	1.35	\$5.35
DAC8534	16	10	String	4	—	+V _{REF}	1	0.0987	16	Serial, SPI	Ext	+ 2.7 to 5.5	0.42	\$9.75
DAC7731	16	5	R-2R	1	—	+10, \pm 10	1	0.0015	16	Serial, SPI	Int/Ext	\pm 14.25 to 15.75	100	\$8.20
DAC8541	16	10	String	1	—	+V _{REF}	1	0.096	16	P16	Ext	+ 2.7 to 5.5	0.72	\$3.00
DAC8571	16	10	String	1	—	+V _{REF}	1	0.0987	16	Serial, I ² C	Ext	+ 2.7 to 5.5	0.42	\$2.95
DAC8574	16	10	String	4	—	+V _{REF}	1	0.0987	16	Serial, I ² C	Ext	+ 2.7 to 5.5	2.7	\$10.25
DAC7741	16	5	R-2R	1	—	\pm 10	1	0.0015	16	P16	Int/Ext	\pm 14.25 to 15.75	100	\$8.30
DAC7742	16	5	R-2R	1	—	+10, \pm 10	1	0.0015	16	P16	Int/Ext	\pm 14.25 to 15.75	100	\$8.70
DAC8580	16	1	String	1	—	V _{REF}	1	0.0987	16	Serial, SPI	Ext	2.7, 5.25	60	\$3.25
DAC8581	16	1	String	1	—	\pm V _{REF}	1	0.0987	16	Serial, SPI	Ext	2.75 to 5.25	60	\$3.25
DAC8830	16	0.5	R-2R	1	—	+V _{REF}	1	0.0015	16	Serial, SPI	Ext	2.75 to 5.25	0.5	\$9.35
DAC8831	16	0.5	R-2R	1	—	\pm V _{REF}	1	0.0015	16	Serial, SPI	Ext	2.75 to 5.25	0.5	\$9.35
DAC8811	16	0.5	R-2R	1	—	\pm V _{REF} /MDAC	1	0.0015	16	Serial, SPI	Ext	2.75 to 5.25	0.5	\$8.50
DAC8812	16	0.5	R-2R	2	—	\pm V _{REF} /MDAC	1	0.0015	16	Serial, SPI	Ext	2.75 to 5.25	0.5	\$10.15
DAC8814	16	0.5	R-2R	4	—	\pm V _{REF} /MDAC	1	0.0015	16	Serial, SPI	Ext	2.75 to 5.25	0.5	\$26.35
DAC8821	16	0.5	R-2R	1	—	\pm V _{REF} /MDAC	1	0.0015	16	P16	Ext	2.75 to 5.25	0.5	\$12.50
DAC5686	16	0.012	I-Steering	2	500	—	9	12LSB	—	2 x P16	Int/Ext	3 to 3.6	445	\$19.75
DAC5687	16	0.012	I-Steering	2	500	20mA	4	6	16	Serial	Int/Ext	1.8/3.3	700	\$22.50
DAC8802	14	0.5	R-2R	2	—	\pm V _{REF} /MDAC	1	0.0061	14	Serial, SPI	Ext	2.75 to 5.25	0.5	\$7.25
DAC8803	14	0.5	R-2R	4	—	\pm V _{REF} /MDAC	1	0.0061	14	Serial, SPI	Ext	2.75 to 5.25	0.5	\$16.95
DAC8804	14	0.5	R-2R	1	—	\pm V _{REF} /MDAC	1	0.0061	14	P16	Ext	2.75 to 5.25	0.5	\$7.15
DAC8801	14	0.5	R-2R	1	—	\pm V _{REF} /MDAC	1	0.0061	14	Serial, SPI	Ext	2.75 to 5.25	0.3	\$5.50
DAC5672	14	0.02	Current	2	200	20mA	3	4	14	—	Int	3.0 to 3.6	330	\$13.25
THS5671A	14	0.035	I-Steering	1	125	20mA	3.5	7LSB	—	P14	Int/Ext	+ 3 to 5.5	175	\$12.85
DAC2904	14	0.03	I-Steering	2	125	20mA	4	5LSB	—	2 x P14	Int/Ext	+ 3 to 5.5	310	\$13.25
DAC904	14	0.03	I-Steering	1	200	20mA	2.5	3LSB	—	P14	Int/Ext	+ 2.7 to 5.5	170	\$7.35
DAC5674	14	0.02	I-Steering	1	400	—	2	3.5LSB	—	P14	Int/Ext	3 to 3.6	435	\$15.00
DAC5675	14	0.005	I-Steering	1	400	20mA	2	4LSB	—	LVDS/P14	Int/Ext	+ 3.15 to 3.6	820	\$29.45
DAC7573	12	10	String	4	—	+V _{REF}	1	0.096	12	Serial, I ² C	Ext	2.75 to 5.25	0.85	\$6.15
DAC7512	12	10	String	1	—	+ V _{CC}	1	0.38	12	Serial, SPI	Ext	+ 2.7 to 5.5	0.345	\$2.70
DAC7513	12	10	String	1	—	+V _{REF}	1	0.38	12	Serial, SPI	Ext	+ 2.7 to 5.5	0.3	\$2.50
DAC7571	12	10	String	1	—	+V _{REF}	—	0.096	12	Serial, I ² C	Ext	+ 2.7 to 5.5	0.85	\$1.55
DAC7574	12	10	String	4	—	+V _{REF}	—	0.096	12	Serial, I ² C	Ext	+ 2.7 to 5.5	0.85	\$6.15

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DAC Selection Guide (Continued)

Device	Res. (Bits)	Settling Time (μ s)	Architecture	Number of Channels	Update Rate (MSPS)	Output (V)	DNL (\pm LSB)	INL (%)	Monotonic (Bits)	Interface	V _{REF}	Supply Voltage (V)	Power (mW) (typ)	Price ¹	Refer to Page #
DAC7611	12	10	R-2R	1	—	4.096	1	0.012	12	Serial, SPI	Int	+ 4.75 to 5.25	5	\$2.55	66
DAC7612	12	10	R-2R	2	—	4.096	1	0.012	12	Serial, SPI	Int	+ 4.75 to 5.25	3.5	\$2.70	66
DAC7613	12	10	R-2R	1	—	+V _{REF} , \pm V _{REF}	1	0.012	12	P12	Ext	\pm or + 4.75 to 5.25	1.8	\$2.50	66
DAC7614	12	10	R-2R	4	—	+V _{REF} , \pm V _{REF}	1	0.012	12	Serial, SPI	Ext	\pm or + 4.75 to 5.25	15	\$6.70	66
DAC7615	12	10	R-2R	4	—	+V _{REF} , \pm V _{REF}	1	0.012	12	Serial, SPI	Ext	\pm or + 4.75 to 5.25	15	\$6.70	66
DAC7616	12	10	R-2R	4	—	+V _{REF} , \pm V _{REF}	1	0.012	12	Serial, SPI	Ext	+ 3 to 3.6	2.4	\$5.40	66
DAC7617	12	10	R-2R	4	—	+V _{REF} , \pm V _{REF}	1	0.012	12	Serial, SPI	Ext	+ 3 to 3.6	2.4	\$5.40	66
DAC7621	12	10	R-2R	1	—	4.096	1	0.012	12	P12	Int	+ 4.75 to 5.25	2.5	\$2.75	66
DAC7624	12	10	R-2R	4	—	\pm V _{REF}	1	0.012	12	P12	Ext	\pm or + 4.75 to 5.25	15	\$10.25	66
DAC7625	12	10	R-2R	4	—	\pm V _{REF}	1	0.012	12	P12	Ext	\pm or + 4.75 to 5.25	15	\$10.25	66
DAC7714	12	10	R-2R	4	—	\pm V _{REF}	1	0.012	12	Serial, SPI	Ext	\pm or + 14.25 to 15.75	45	\$11.45	66
DAC7715	12	10	R-2R	4	—	\pm V _{REF}	1	0.012	12	Serial, SPI	Ext	\pm or + 14.25 to 15.75	45	\$11.45	66
DAC7724	12	10	R-2R	4	—	\pm V _{REF}	1	0.012	12	P12	Ext	\pm or + 14.25 to 15.75	45	\$11.85	66
DAC7725	12	10	R-2R	4	—	\pm V _{REF}	1	0.012	12	P12	Ext	\pm or + 14.25 to 15.75	45	\$11.85	66
DAC7554	12	5	R-2R	4	—	\pm V _{REF}	1	0.012	12	Serial, SPI	Ext	2.75 to 5.25	1	\$5.60	66
DAC811	12	4	R-2R	1	—	+10, \pm 5, 10	0.5	0.006	12	P12	Int	\pm or + 11.4 to 16.5	625	\$11.00	66
DAC813	12	4	R-2R	1	—	+10, \pm 5, 10	0.5	0.006	12	P12	Int/Ext	\pm or + 11.4 to 16.5	270	\$12.60	66
TLV5614	12	3	String	4	—	+V _{REF}	1	0.1	12	Serial, SPI	Ext	+ 2.7 to 5.5	3.6	\$7.45	66, 76
TLV5616	12	3	String	1	—	+V _{REF}	1	0.1	12	Serial, SPI	Ext	+ 2.7 to 5.5	0.9	\$2.60	66, 76
TLV5618A	12	2.5	String	2	—	+V _{REF}	1	0.08	12	Serial, SPI	Ext	+ 2.7 to 5.5	1.8	\$4.75	66, 76
DAC7545	12	2	R-2R	1	—	\pm V _{REF} /MDAC	1	0.012	12	P12	Ext	+ 5 to 16	30	\$5.25	66
DAC7541	12	1	R-2R	1	—	\pm V _{REF} /MDAC	0.5	0.012	12	P12	Ext	+ 5 to 16	30	\$6.70	66
DAC8043	12	1	R-2R	1	—	\pm V _{REF} /MDAC	1	0.012	12	Serial, SPI	Ext	+ 4.75 to 5.25	2.5	\$5.25	66
TLV5610	12	1	String	8	—	+V _{REF}	1	0.4	12	Serial, SPI	Ext	+ 2.7 to 5.5	18	\$8.50	68
TLV5613	12	1	String	1	—	+V _{REF}	1	0.1	12	P8	Ext	+ 2.7 to 5.5	1.2	\$2.60	67
TLV5619	12	1	String	1	—	+V _{REF}	1	0.08	12	P12	Ext	+ 2.7 to 5.5	4.3	\$2.60	67
TLV5630	12	1	String	8	—	+V _{REF}	1	0.4	12	Serial, SPI	Int/Ext	+ 2.7 to 5.5	18	\$8.85	67, 77
TLV5633	12	1	String	1	—	+2, 4	0.5	0.08	12	P8	Int/Ext	+ 2.7 to 5.5	2.7	\$4.70	67
TLV5636	12	1	String	1	—	+2, 4	1	0.1	12	Serial, SPI	Int/Ext	+ 2.7 to 5.25	4.5	\$3.65	67, 77
TLV5638	12	1	String	2	—	+2, 4	1	0.1	12	Serial, SPI	Int/Ext	+ 2.7 to 5.25	4.5	\$3.25	67, 77
TLV5639	12	1	String	1	—	+2, 4	0.5	0.1	12	P12	Int/Ext	+ 2.7 to 5.25	2.7	\$3.45	67
DAC7800	12	0.8	R-2R	2	—	1mA	1	0.012	12	Serial, SPI	Ext	+ 4.5 to 5.5	1	\$13.55	67
DAC7801	12	0.8	R-2R	2	—	1mA	1	0.012	12	P12	Ext	+ 4.5 to 5.5	1	\$17.95	67
DAC7802	12	0.8	R-2R	2	—	1mA	1	0.012	12	P12	Ext	+ 4.5 to 5.5	1	\$14.00	67
DAC7811	12	0.5	R-2R	1	—	\pm V _{REF} /MDAC	1	0.0244	12	Serial, SPI	Ext	2.75 to 5.25	0.5	\$3.15	67
DAC5662	12	0.2	Current	2	200	20mA	2	2	12	Serial	Ext	3.0 to 3.6	330	\$10.70	69
THS5661A	12	0.035	I-Steering	1	125	20mA	2	4LSB	—	P12	Int/Ext	+ 3 to 5.5	175	\$6.60	69
DAC2902	12	0.03	I-Steering	2	125	20mA	2.5	3LSB	—	2 x P12	Int/Ext	+ 3 to 5.5	310	\$10.70	69
DAC902	12	0.03	I-Steering	1	200	20mA	1.75	2.5LSB	—	P12	Int/Ext	+ 2.7 to 5.5	170	\$5.95	69

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.

DAC Selection Guide (Continued)

Device	Res. (Bits)	Settling Time (μ s)	Architecture	Number of Channels	Update Rate (MSPS)	Output (V)	DNL (\pm LSB)	INL (%)	Monotonic (Bits)	Interface	V _{REF}	Supply Voltage (V)	Power (mW) (typ)	Price ¹	Refer to Page
DAC2932	12	0.025	I-Steering	2	40	2mA	0.5	2LSB	—	P12	Int/Ext	+2.7 to 3.3	29	\$8.35	69
TLC5615	10	12.5	String	1	—	+V _{REF}	0.5	0.1	10	Serial, SPI	Ext	+ 4.5 to 5.5	0.75	\$1.90	67
DAC6571	10	9	String	1	—	V _{DD}	0.5	0.195	10	Serial, I ² C	Ext	2.75 to 5.25	0.5	\$1.40	67
DAC6573	10	9	String	4	—	+V _{REF}	0.5	0.195	10	Serial, I ² C	Ext	2.75 to 5.25	1.5	\$3.05	67
DAC6574	10	9	String	4	—	+V _{REF}	0.5	0.195	10	Serial, I ² C	Ext	2.7 to 5.5	1.5	\$3.05	67
TLV5604	10	3	String	4	—	+V _{REF}	1	0.05	10	Serial, SPI	Ext	+ 2.7 to 5.5	3	\$3.70	67, 76
TLV5606	10	3	String	1	—	+V _{REF}	1	0.15	10	Serial, SPI	Ext	+ 2.7 to 5.5	0.9	\$1.30	67, 76
TLV5617A	10	2.5	String	2	—	+V _{REF}	0.5	0.1	10	Serial, SPI	Ext	+ 2.7 to 5.5	1.8	\$2.25	67, 76
TLV5608	10	1	String	8	—	+V _{REF}	1	0.4	10	Serial, SPI	Ext	+ 2.7 to 5.5	18	\$4.90	76
TLV5631	10	1	String	8	—	+V _{REF}	1	0.4	10	Serial, SPI	Int/Ext	+ 2.7 to 5.5	18	\$5.60	67, 77
TLV5637	10	0.8	String	2	—	+2, 4	0.5	0.1	10	Serial, SPI	Int/Ext	+ 2.7 to 5.25	4.2	\$3.20	67, 77
DAC5652	10	0.02	I-Steering	2	200	20mA	1	0.5	10	Serial	Int/Ext	3.0 to 3.6	290	\$7.60	69
THS5651A	10	0.035	I-Steering	1	100	20mA	0.5	1LSB	—	P10	Int/Ext	+ 3 to 5.5	175	\$4.50	69
DAC2900	10	0.03	I-Steering	2	125	20mA	1	1LSB	—	2 x P10	Int/Ext	+ 3 to 5.5	310	\$6.00	69
DAC900	10	0.03	I-Steering	1	200	20mA	0.5	1LSB	—	P10	Int/Ext	+ 2.7 to 5.5	170	\$4.20	69
TLC5628	8	10	String	8	—	+V _{REF}	0.9	0.4	8	Serial, SPI	Ext	+ 4.75 to 5.25	15	\$2.45	67
TLV5620	8	10	R-2R	4	—	+V _{REF}	0.9	0.2	8	Serial, SPI	Ext	+ 2.7 to 5.5	6	\$1.00	67
TLV5621	8	10	R-2R	4	—	+V _{REF}	0.9	0.4	8	Serial, SPI	Ext	+ 2.7 to 5.5	3.6	\$1.65	67
TLV5628	8	10	String	8	—	+V _{REF}	0.9	0.4	8	Serial, SPI	Ext	+ 2.7 to 5.25	12	\$2.20	67
TLC5620	8	10	String	4	—	+V _{REF}	0.9	0.4	8	Serial, SPI	Ext	+ 4.75 to 5.25	8	\$1.50	67
DAC5571	8	8	String	1	—	V _{DD}	0.25	0.195	8	Serial, I ² C	Int	2.75 to 5.25	0.5	\$0.90	67
DAC5573	8	8	String	4	—	+V _{REF}	0.25	0.195	8	Serial, I ² C	Ext	2.75 to 5.25	1.5	\$2.55	67
DAC5574	8	8	String	4	—	+V _{REF}	0.25	0.195	8	Serial, I ² C	Ext	2.7 to 5.5	1.5	\$2.55	67
TLC7225	8	5	R-2R	4	—	\pm V _{REF}	1	0.4	8	P8	Ext	\pm or + 11.4 to 16.5	75	\$2.35	67
TLC7226	8	5	R-2R	4	—	+V _{REF}	1	0.4	8	P8	Ext	\pm or + 11.4 to 16.5	90	\$2.15	67
TLV5623	8	3	String	1	—	+V _{REF}	0.2	0.2	8	Serial, SPI	Ext	+ 2.7 to 5.5	2.1	\$0.99	67, 76
TLV5625	8	3	String	2	—	+V _{REF}	0.2	0.2	8	Serial, SPI	Ext	+ 2.7 to 5.5	2.4	\$1.70	67, 76
TLV5627	8	2.5	String	4	—	+V _{REF}	0.5	0.2	8	Serial, SPI	Ext	+ 2.7 to 5.5	3	\$2.05	67
TLV5624	8	1	String	1	—	+2, 4	0.2	0.2	8	Serial, SPI	Int/Ext	+ 2.7 to 5.5	0.9	\$1.60	67, 77
TLV5629	8	1	String	8	—	+V _{REF}	1	0.4	8	Serial, SPI	Ext	+ 2.7 to 5.5	18	\$3.15	67, 77
TLV5632	8	1	String	8	—	+2, 4	1	0.4	8	Serial, SPI	Int/Ext	+ 2.7 to 5.5	18	\$3.35	67, 77
TLV5626	8	0.8	String	2	—	+2, 4	0.5	0.4	8	Serial, SPI	Int/Ext	+ 2.7 to 5.5	4.2	\$1.90	67, 77
TLC7524	8	0.1	R-2R	1	—	1mA	0.5	0.2	8	P8	Ext	+ 4.75 to 5.25	5	\$1.45	67
TLC7528	8	0.1	R-2R	2	—	1mA	0.5	0.2	8	P8	Ext	+ 4.75 to 15.75	7.5	\$1.55	67
TLC7628	8	0.1	R-2R	2	—	2mA	0.5	0.2	8	P8	Ext	+ 10.8 to 15.75	20	\$1.45	67

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Video ADC Selection Guide

Device	Res. (Bits)	Sample Rate (MSPS)	Analog Inputs	Analog Input Bandwidth (MSPS)	Input Range (V)	SNR (dB)	DNL (LSB)	INL (LSB)	Host Interface	Number of Supplies	Analog Supply	Logic Supply	Power (typ) (mW)	Package	Price ¹	Refer to Page #
THS8083A	8	80	3	500	1.2	42	1.5	2	I ² C	1	3.0 to 3.6	3.0 to 3.6	1470	HTQFP-100	\$7.06	—
TLV5734	8	30	3	500	1	42	1.5	0.75	—	1	3.0 to 3.6	3.0 to 3.6	250	TQFP-64	\$4.75	—

Video DAC Selection Guide

Device	Res. (Bits)	Sample Rate (MSPS)	Analog Outputs	Analog Output Bandwidth (MSPS)	SFDR (dB)	DNL (LSB)	INL (LSB)	Color Space Conv.	Embedded Sync. Detection	Interpolation Filter	Internal Scaling	Number of Supplies	Analog Supply	Logic Supply	Power (mW) (typ)	Package	Price ¹	Refer to Page
THS8135	10	240	3	120	55	-0.25 to +0.5	±0.6	No	No	No	No	2	3.0 to 3.6	1.65 to 2.0	380	HTQFP-48	\$11.05	—
THS8200	10	205	3	100	55	±0.5	±1.5	Yes	Yes	Yes	Yes	2	3.0 to 3.6	1.65 to 2.0	635	HTQFP-80	\$15.25	—
THS8133B	10	80	3	40	64	-0.2 to +0.6	±0.5	No	No	No	No	1 or 2	4.75 to 5.25	3.0 to 5.25	525	HTQFP-48	\$7.80	—
THS8134B	8	80	3	40	62	±0.2	±0.2	No	No	No	No	1 or 2	4.75 to 5.25	3.0 to 5.25	525	HTQFP-48	\$5.85	—

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Voiceband Codecs Selection Guide

Device1	Description	Res. (Bits)	Sample Rate (kHz)	Number of Input Channels	Dynamic Range (dB)	SNR (dB)	Interface	Number of Supplies	Analog Supply	Logic Supply	Power (mW) (typ)	Package(s)	Price ¹	Refer to Page #
AIC111	Voiceband Codec	20	40	1	87	87	SPI, DSP	1 or 2	1.1 to 1.5	1.1 to 3.3	0.46	QFN-32, FlipChip	\$4.14	77, 83
TLV320AIC12K	Voiceband Codec	16	26	1	88	90	I ² C, S ² C, DSP	2 or 3	1.65 to 1.95/2.7 to 3.6	1.1 to 3.6	10	TSSOP-30	\$2.90	77, 83
TLV320AIC14K	Voiceband Codec	16	26	1	88	90	I ² C, S ² C, DSP	2 or 3	1.65 to 1.95/2.7 to 3.6	1.1 to 3.6	10	TSSOP-30	\$2.45	77, 83
TLV320AIC20K	Voiceband Codec	16	26	2	84	90	I ² C, S ² C, DSP	2 or 3	1.65 to 1.95/2.7 to 3.6	1.1 to 3.6	20	TQFP-48	\$3.70	77, 83
TLV320AIC24K	Voiceband Codec	16	26	2	84	90	I ² C, S ² C, DSP	2 or 3	1.65 to 1.95/2.7 to 3.6	1.1 to 3.6	20	TQFP-48	\$3.55	83
TLV320AIC10	Voiceband Codec	16	22	1	84	84	S ² C, DSP	1 or 2	3 to 5.5	3 to 5.5	39	TQFP-48, VFBGA-80	\$2.40	77, 83
TLV320AIC11	Voiceband Codec	16	22	1	84	84	S ² C, DSP	1 or 2	3 to 5.5	1.1 to 3.6	39	TQFP-48	\$2.40	77, 83
TLC320AD545	Voiceband Codec	16	11	1	80	82	DSP	1	3.3 to 5	3.3 to 5	120	TQFP-48	\$3.10	83
TLV320AIC1103	Voiceband Codec	15	8	1	84	65	I ² C	1	2.7 to 3.3	2.7 to 3.3	16	TQFP-32, VFBGA-80	\$2.80	83
TLV320AIC1109	Voiceband Codec	15	8	1	45	65	I ² C	1	2.7 to 3.3	2.7 to 3.3	16.2	TQFP-32	\$2.65	83
TLV320AIC1110	Voiceband Codec	15	8	1	45	65	I ² C	1	2.7 to 3.3	2.7 to 3.3	16.2	TQFP-32, VFBGA-80	\$2.70	83
TLV320AIC1106	Voiceband Codec	13	8	1	82	65	PCM	1	2.7 to 3.3	2.7 to 3.3	13.5	TSSOP-20	\$2.70	83
TLV320AIC1107	Voiceband Codec	13	8	1	45	65	PCM	1	2.7 to 3.3	2.7 to 3.3	13.5	TSSOP-20	\$2.70	83

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Touch Screen Controller Selection Guide

Device	Res. (Bits)	Sample Rate (kSPS)	Touch Panel	Data Interface	Audio Interface	Reg. Based	Data Average	Prog. Settle	Aux Bat	B / T / P Sensor	Mic. AGC	V _{REF}	Audio Outputs	LCD DAC	Key- Pad	PWR Down	Number of Supplies	Analog Supply	Logic Supply (V)	Price ¹	Refer to Page #
ADS7843	12 (8)	Up to 125	4-Wire	Serial, SPI	—	No	No	No	2	No	—	Ext	—	No	—	Yes	1	2.7 to 5.25	2.7 to 5.25	\$1.70	80
ADS7845	12 (8)	Up to 125	5-Wire	Serial, SPI	—	No	No	No	1	No	—	Ext	—	No	—	Yes	1	2.7 to 5.25	2.7 to 5.25	\$4.20	80
ADS7846	12 (8)	Up to 125	4-Wire	Serial, SPI	—	No	No	No	2	Yes	—	Int	—	No	—	Yes	1	2.7 to 5.25	2.7 to 5.25	\$2.05	80
TSC2000	8, 10, 12	Up to 125	4-Wire	Serial, SPI	—	Yes	Yes	Yes	4	Yes	—	Int	—	Yes	—	Yes	1	2.7 to 3.6	2.7 to 3.6	\$2.35	80
TSC2003	12 (8)	Up to 125	4-Wire	Serial, I ² C	—	No	No	No	4	Yes	—	Int	—	No	—	Yes	1	2.7 to 5.25	2.7 to 5.25	\$2.25	80
TSC2046	12 (8)	Up to 125	4-Wire	Serial, SPI	—	No	No	No	2	Yes	—	Int	—	No	—	Yes	1 or 2	2.2 to 5.25	1.5 to 5.25	\$1.80	80
TSC2200	8, 10, 12	Up to 125	4-Wire	Serial, SPI	—	Yes	Yes	Yes	4	Yes	—	Int	—	Yes	4 x 4	Yes	1	2.7 to 3.6	2.7 to 3.6	\$2.40	80
TSC2100	8, 10, 12	Up to 125	4-Wire	Serial, SPI	I ² S	Yes	Yes	Yes	3	Yes	HW	Int	St. Line/HP/8Ω	No	—	Yes	2 or 3	2.7 to 3.6	1.525 to 1.95	\$3.95	80, 89
TSC2101	8, 10, 12	Up to 125	4-Wire	Serial, SPI	I ² S	Yes	Yes	Yes	3	Yes	HW	Int	St. Line/HP, 8Ω, 32Ω, Mono	No	—	Yes	3 or 4	3.0 to 3.6	1.65 to 1.95	\$4.95	80, 81, 89
TSC2102	8, 10, 12	Up to 125	4-Wire	Serial, SPI	I ² S	Yes	Yes	Yes	3	Yes	—	Int	St. Line/HP	No	—	Yes	2 or 3	2.7 to 3.6	1.525 to 1.95	\$3.70	80, 89
TSC2300	8, 10, 12	Up to 125	4-Wire	Serial, SPI	I ² S	Yes	Yes	Yes	4	Yes	SW	Int	St. Line/HP, Mono	Yes	4 x 4	Yes	1	2.7 to 3.6	2.7 to 3.6	\$4.75	80
TSC2301	8, 10, 12	Up to 125	4-Wire	Serial, SPI	I ² S	Yes	Yes	Yes	4	Yes	SW	Int	St. Line/HP, Mono	Yes	4 x 4	Yes	1	2.7 to 3.6	2.7 to 3.6	\$4.95	80, 89
TSC2302	8, 10, 12	Up to 125	4-Wire	Serial, SPI	I ² S	Yes	Yes	Yes	4	Yes	SW	Int	HP, Mono	Yes	—	Yes	1	2.7 to 3.6	2.7 to 3.6	\$4.50	80, 89

¹Suggested resale price in U.S. dollars in quantities of 1,000.

Audio ADC Selection Guide

Device	Description	Res. (Bits)	Sample Rate (kSPS)	Dynamic Range (dB)	Audio Interface	Number of Supplies	Analog Supply	Logic Supply	Power (mW) (typ)	Package	Price ¹	Refer to Page #
PCM4201	Single-Channel Low-Power ADC	24	96	112	Normal, I ² S	2	4.75 to 5.25	3 to 3.6	39	TSSOP-16	\$3.50	85, 89
PCM4204	High-Performance ADC	24	192	118	Normal, I ² S, DSD, TDM	2	4.75 to 5.25	3 to 3.6	600	TQFP-48	\$14.95	84, 89
PCM4202	High-Performance ADC	24	192	118	Normal, I ² S, DSD	2	4.75 to 5.25	3 to 3.6	300	SSOP-28	\$7.95	75, 89
PCM1804	High-Performance ADC	24	192	112	Normal, I ² S, DSD	2	4.75 to 5.25	3 to 3.6	225	SSOP-28	\$5.20	75, 89
PCM1850	$\Delta\Sigma$ Audio ADC with 6-Input MUX	24	96	102	Normal, I ² S	2	3.3 to 5.0	3.3 to 5.0	160	TQFP-32	\$4.80	89
PCM1802	$\Delta\Sigma$ Audio ADC	24	96	100	Normal, I ² S	2	4.5 to 5.5	2.7 to 3.6	147	SSOP-20	\$3.35	89
PCM1800	CMOS, Multilevel	20	48	95	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	90	SSOP-24	\$2.60	89
PCM1801	Low-Cost Audio ADC	16	48	93	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	90	SO-14	\$2.40	89

¹ Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**.

Audio DAC Selection Guide

Device	Description	Res. (Bits)	Sample Rate (kSPS)	Number of Channels	Dynamic Range (dB)	SNR (dB)	Audio Interface	Number of Supplies	Analog Supply	Logic Supply	Power (typ) (mW)	Package(s)	Price ¹	Refer to Page #
TLV320DAC23	Low-Power Audio DAC with Headphone Amp	32	96	Stereo	100	100	MSB/LSB Justified, I ² S	2	2.7 to 3.6	1.42 to 3.6	—	TSSOP-28, QFN-32, VFBGA-80	\$1.90	77, 83
TLV320DAC26	Low-Power Audio DAC with Headphone/ Speaker Amp	32	53	Stereo	97	97	Normal, I ² S, DSP	2	2.7 to 3.6	1.525 to 1.95	—	QFN-32	\$2.95	88
PCM1704	High-Performance, BiCMOS, Sign Magnitude	24	768	Mono	112	120	Serial Latched	1	±4.75 to ±5.25	±4.75 to ±5.25	175	SOIC-20	\$12.95	88
PCM1753/54/55	Low-Cost Audio DAC with Volume Control	24	192	Stereo	106	106	Normal, I ² S	2	4.5 to 5.5	4.5 to 5.5	80	SSOP-16	\$1.05	88
PCM1792/94	High-Performance, Advance Segment	24	192	Stereo	128	129	Normal, I ² S, DSD	2	4.75 to 5.25	3.0 to 3.6	205	SSOP-28	\$13.00	88
PCM1796/98	High-Performance, Advance Segment	24	192	Stereo	123	123	Normal, I ² S, DSD	2	4.75 to 5.25	3.0 to 3.6	115	SSOP-28	\$6.50	88
PCM4104/4108	High-Performance	24	192	4/8	118	120	Normal, I ² S, TDM	2	4.5 to 5.5	3.0 to 3.6	200/400	TQFP-48/HTQFP-64	\$7.95/\$9.95	88
PCM1738/30	High-Performance, Advanced Segment	24	192	Stereo	117	117	Normal, I ² S, DSD	2	4.75 to 5.25	3.0 to 3.6	188	SSOP-28	\$4.75	88
PCM1791/93	High-Performance, Advanced Segment	24	192	Stereo	113	113	Normal, I ² S, DSD	2	4.5 to 5.5	3.0 to 3.6	90	SSOP-28	\$3.00	88
DSD1702	PCM/DSD Compatible	24	192	Stereo	106	106	Normal, I ² S, DSD	2	4.5 to 5.5	3.0 to 3.6	76	SSOP-20	\$1.85	88
PCM1737/39	CMOS, Multilevel $\Delta\Sigma$ with Volume Control	24	192	Stereo	106	105	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	93	SSOP-28	\$3.49	88
PCM1742K	Low-Cost Audio DAC with Volume Control	24	192	Stereo	106	106	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	62	SSOP-16	\$1.72	88
PCM1602	Low-Cost, CMOS, Multilevel, $\Delta\Sigma$	24	192	6	100	100	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	171	LQFP-48	\$3.08	88
PCM1742	Low-Cost Audio DAC with Volume Control	24	192	Stereo	100	100	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	62	SSOP-16	\$1.56	88
PCM1602K	Low-Cost, CMOS, Multilevel, $\Delta\Sigma$	24	192	6	105	105	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	171	LQFP-48	\$3.39	88
PCM1604	CMOS, Multilevel, $\Delta\Sigma$	24	192	6	105	104	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	266	LQFP-48	\$4.35	88
PCM1605	CMOS, Multilevel, $\Delta\Sigma$	24	192	6	105	104	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	266	MQFP-48	\$4.35	88
PCM1606	Low-Cost, CMOS, Multilevel, $\Delta\Sigma$	24	192	6	103	103	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	250	SSOP-20	\$1.90	88
DSD1608	Enhanced Multiformat, $\Delta\Sigma$	24	192	8	108	108	Normal, I ² S, DSD	2	4.5 to 5.5	3.0 to 3.6	270	TWFP-52	\$5.68	88
PCM1608	Enhanced Multiformat, $\Delta\Sigma$	24	192	8	108	100	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	224	TQFP-52	\$5.68	88
PCM1608K	CMOS, Multilevel, $\Delta\Sigma$	24	192	8	105	105	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	224	LQFP-48	\$4.50	88
PCM1716/28	CMOS, Multilevel, $\Delta\Sigma$	24	96	Stereo	106	106	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	160	SSOP-28	\$2.99	88
PCM1720	CMOS, Multilevel, $\Delta\Sigma$ with Volume Control	24	96	Stereo	96	100	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	125	SSOP-20	\$1.85	88

¹ Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.

Audio DAC Selection Guide (Continued)

Device	Description	Res. (Bits)	Sample Rate (kSPS)	Number of Channels	Dynamic Range (dB)	SNR (dB)	Audio Interface	Number of Supplies	Analog Supply	Logic Supply	Power (typ) (mW)	Package(s)	Price ¹	Refer to Page #
PCM1723	With Internal PLL, Generate DAD/MPEG Clocks	24	96	Stereo	94	96	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	100	SSOP-24	\$2.20	88
PCM1727	With Internal, Dual-PLL, for DAD/MPEG Systems	24	96	Stereo	92	94	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	125	SSOP-24	\$2.97	88
PCM1740	With Internal, VCXO and PLL	24	96	Stereo	94	94	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	125	SSOP-24	\$2.97	88
PCM1741	Low-Cost Audio DAC with Volume Control	24	96	Stereo	98	98	Normal, I ² S	1	2.7 to 3.6	2.7 to 3.6	43	SSOP-16	\$1.46	88
PCM1744	Low-Cost Audio DAC	24	96	Stereo	95	97	I ² S	1	4.5 to 5.5	4.5 to 5.5	65	SO-14	\$1.26	88
PCM1748	Low-Cost Audio DAC	24	96	Stereo	100	100	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	62	SSOP-16	\$1.47	88
PCM1748K	Low-Cost Audio DAC with Volume Control	24	96	Stereo	106	106	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	62	SSOP-16	\$1.21	88
PCM1600	CMOS, Multilevel, $\Delta\Sigma$ DAC	24	96	6	105	104	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	266	LQFP-48	\$3.95	88
PCM1601	CMOS, Multilevel, $\Delta\Sigma$ DAC	24	96	6	105	104	Normal, I ² S	2	4.5 to 5.5	3.0 to 3.6	266	MQFP-48	\$3.95	88
PCM1770	Low-Power Audio DAC w/Headphone Amp	24	48	Stereo	98	98	Left/Right Justified, I ² S	1	1.6 to 3.6	1.6 to 3.6	6.5	TSSOP-16, VQFN-20	\$1.80	88
PCM1771	Low-Power Audio DAC w/Headphone Amp	24	48	Stereo	98	98	Left/Right Justified, I ² S	1	1.6 to 3.6	1.6 to 3.6	6.5	TSSOP-16, VQFN-20	\$1.80	88
PCM1772	Low-Power Audio DAC with Line Amp	24	48	Stereo	98	98	Left/Right justified, I ² S	1	1.6 to 3.6	1.6 to 3.6	6	TSSOP-16, VQFN-20	\$1.80	88
PCM1773	Low-Power Audio DAC with Line Amp	24	48	Stereo	98	98	Left/Right Justified	1	1.6 to 3.3	1.6 to 3.3	6	TSSOP-16, VQFN-20	\$1.80	88
PCM1702P/U	High Performance, BiCMOS, Sign Magnitude	20	768	Mono	110	120	Serial Latched	1	± 4.75 to ± 5.25	± 4.75 to ± 5.25	150	DIP-16, SOP-20	\$11.78	88
PCM1710	High Performance, CMOS, Multilevel, $\Delta\Sigma$	20	48	Stereo	98	110	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	225	SOIC-28	\$4.00	88
PCM1733	Low-Cost Audio DAC	18	96	Stereo	95	97	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	65	SO-14	\$1.26	88
PCM1717/18	Stereo Audio DAC with Wide Supply Range	18	48	Stereo	96	100	Normal, I ² S	1	2.7 to 5.5	2.7 to 5.5	90	SSOP-20	\$3.21	88
PCM1719	Stereo Audio DAC with Headphone Amplifier	18	48	Stereo	96	100	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	90	SSOP-28	\$4.20	88
PCM1725	Low-Cost Audio DAC	16	96	Stereo	95	97	Normal, I ² S	1	4.5 to 5.5	4.5 to 5.5	65	SO-14	\$1.26	88
PCM2702	Stereo Audio DAC, Self-Powered	16	48	Stereo	100	105	USB	2	4.5 to 5.5	3.0 to 3.6	165	SSOP-28	\$5.51	88
DSD1700	High Performance, Mono-Channel, DSD DAC	—	—	Mono	110	110	DSD	1	4.5 to 5.5	4.5 to 5.5	27.5	SSOP-28	\$9.95	88

¹ Suggested resale price in U.S. dollars in quantities of 1,000.

Audio Codecs Selection Guide

Device	Description	Power Dissipation (mW)	DAC SNR (dB)	ADC SNR (dB)	Sampling Rate (kHz) (max)	Resolution (Bits)	Power Supply (V)	Package(s)	Price ¹	Refer to Page #
TLV320AIC23B	Low-Power Codec w/Headphone Amp	59	100	90	96	32	IO: 2.7 to 3.6; Analog: 2.7 to 3.6; Logic: 1.42 to 3.6	TSSOP-28, QFN-32, VFBGA-80	\$3.19	77
TLV320AIC26	Low-Power Codec w/Headphone/Speaker Amp	11	97	92	53	32	IO: 1.1 to 3.6; Analog: 3.6 to 3.6; Logic: 1.525 to 1.95	QFN-32	\$3.25	87, 89
TLV320AIC28	Full-Featured Low-Power Codec w/Headphone/Speaker Amp	19	95	90	53	32	IO: 1.1 to 3.6; Analog: 3.0 to 3.6; Logic: 1.65 to 1.95	QFN-48	\$3.95	89
PCM3010	High-Performance Stereo Codec	190	—	—	96/192	24	+3.3 to +5	SSOP-24	\$3.80	89
TLV320AIC32	Low-Power Stereo Codec with Headphone/Speaker Amp	11	103	92	96	24	IO: 1.1 to 3.6; Analog: 2.7 to 3.6; Digital: 1.525 to 1.95	QFN-32	\$3.45	86, 89
TLV320AIC33	Low-power Stereo Codec with Headphone/Speaker Amp	11	103	92	96	24	IO: 1.1 to 3.6; Analog: 2.7 to 3.6; Digital: 1.525 to 1.95	QFN-48, BGA-80	\$3.95	86, 89
PCM3002/03	Low-Power Stereo Audio Codec	54	—	—	48	20	+2.7 to +3.6	SSOP-24	\$3.27	77, 83, 89
PCM3000/1	Stereo Audio Codec	160	—	—	48	18	+5	SSOP-28	\$3.27	89
PCM3008	Low-Power Stereo Audio Codec	32	—	—	48	16	+2.7 to +3.6	SSOP-24	\$3.10	89

¹ Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**. Preview products are listed in **bold blue**.

8051-Based Intelligent $\Delta\Sigma$ MicroSystems Selection Guide

Device	ADC Res. (Bits)	Sample Rate (kSPS)	Number of Input Channels	Input Voltage (V)	V _{REF}	CPU Core	Program Memory (kB)	Program Memory Type	SRAM (kB)	Power (mW/V)	DAC Output (Bits)	Price ¹	Refer to Page #
MSC1200Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	0.1	3/2.7-5.25	8-bit IDAC	\$5.95	71
MSC1200Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	0.1	3/2.7-5.25	8-bit IDAC	\$6.45	71
MSC1201Y2	24	1	6 Diff/6 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	0.1	3/2.7-5.25	8-bit IDAC	\$5.60	70, 71
MSC1201Y3	24	1	6 Diff/6 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	0.1	3/2.7-5.25	8-bit IDAC	\$5.95	70, 71
MSC1210Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	16-bit PWM	\$8.95	70, 71
MSC1210Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	16-bit PWM	\$9.85	70, 71
MSC1210Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	16-bit PWM	\$10.75	71
MSC1210Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	16-bit PWM	\$12.00	71
MSC1211Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$17.50	71
MSC1211Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$17.95	71
MSC1211Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$19.35	71
MSC1211Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$20.95	71
MSC1212Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$16.95	71
MSC1212Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$17.55	71
MSC1212Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$18.85	71
MSC1212Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	4 x 16-bit I/VDAC	\$20.40	71
MSC1213Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$12.65	71
MSC1213Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$13.20	71
MSC1213Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$14.45	71
MSC1213Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$15.95	71
MSC1214Y2	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$12.15	71
MSC1214Y3	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$12.70	71
MSC1214Y4	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	16	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$13.95	71
MSC1214Y5	24	1	8 Diff/8 SE	PGA (1-128), ± 2.5	Int	8051	32	Flash	1.2	4/2.7-5.25	2 x 16-bit I/VDAC	\$15.45	71
MSC1202Y2	16	2	6 Diff/6 SE	PGA (1-128), ± 2.5	Int	8051	4	Flash	0.2	3/2.7-5.25	8-bit IDAC	\$4.60	71
MSC1202Y3	16	2	6 Diff/6 SE	PGA (1-128), ± 2.5	Int	8051	8	Flash	0.2	3/2.7-5.25	8-bit IDAC	\$4.95	71

¹Suggested resale price in U.S. dollars in quantities of 1,000.New products are listed in **bold red**.



Technology Primer

Understanding the relative advantages of basic semiconductor technologies will help in selecting the proper device for a specific application.

CMOS Amps—when low voltage and/or low power consumption, an excellent speed/power ratio, rail-to-rail performance, low cost and small packaging are primary design considerations, choose a CMOS amp. TI has the world's most complete portfolio of high-performance, low-power CMOS amps in a variety of micropackages.

High-Speed Bipolar Amps—when the highest speed at the lowest power is required, bipolar technology delivers the best performance. Extremely good power gain gives very high output power and full power bandwidths on the lowest

quiescent power. Higher voltage requirements are also only satisfied in bipolar technologies.

Precision Bipolar Amps—excel in limiting errors relating to offset voltage. These amps include low offset voltage and temperature drift, high open-loop gain and common-mode rejection. Precision bipolar op amps are used extensively in applications where the source impedance is low, such as a thermocouple amplifier, and where voltage errors, offset voltage and drift, are crucial to accuracy.

Low IB FET Amps—when input impedance is very high, FET-input amps provide better overall precision than bipolar-input amps. Using a bipolar amp in applications with high source impedance (e.g., 500M Ω pH probe), the offset, drift and noise produced

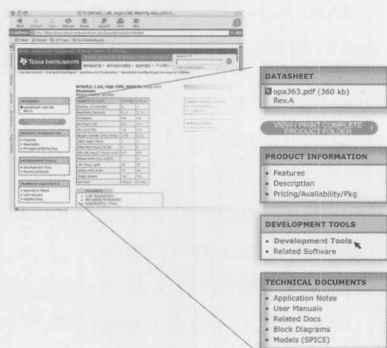
by bias currents flowing through the source would render the circuit virtually useless. When low current errors are required, FET amps provide extremely low input bias current, low offset current and high input impedance.

Dielectrically Isolated FET (DiFET) Amps—DiFET processing enables the design of extremely low input leakage amplifiers by eliminating the substrate junction diode present in junction isolated processes. This technique yields very high-precision, low-noise op amps. DiFET processes also minimize parasitic capacitance and output transistor saturation effects, resulting in improved bandwidth and wider output swing.




Amplifier Evaluation Modules

To ease and speed the design process, TI offers evaluation modules (EVMs) for many amplifiers and other analog products. EVMs contain an evaluation board, product data sheet and user's guide.

To find specific EVMs, visit amplifier.ti.com/evm or the Development Tools section of any individual product folder (below).



amplifier.ti.com/evm

	High-Speed Operational Amplifiers	Operational Amplifiers	Audio Power Amplifiers
Hardware Tools			
Development Boards/EVMs	✓ Fully-Populated Ready-to-Use 	✓ Universal Amplifier Boards 	✓ Fully-Populated Ready-to-use 

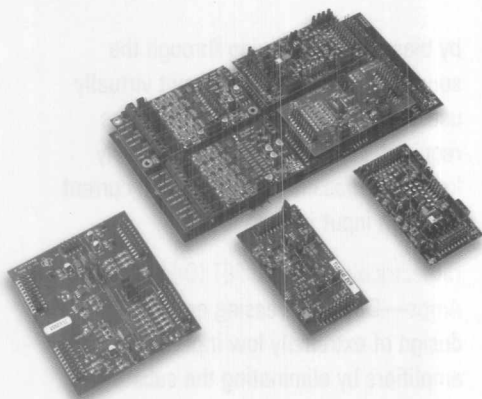
Every high-speed and audio power amplifier has a fully populated, ready-to-use EVM available. Populated evaluation boards are also available for selected other TI amplifiers. Please see the individual device product folder on the TI website or contact your local TI sales office for additional choices and availability.

Universal op amp EVMs are unpopulated printed circuit boards that eliminate the need for dual in-line samples in the evaluation of TI amplifiers. These boards feature:

- Various packages and shutdown
- The ability to evaluate single, dual, or quad amps on several eval spaces per board

- Detachable circuit board development areas for improved portability
- Users manuals with complete board schematic, board layout and numerous standard example circuits
- Product-level Macro Models, designed for use with SPICE, allow efficient simulation of complex circuits without having to use transistor-level models. Download individual models at amplifier.ti.com/spice

To order your universal op amp EVMs, contact the nearest Product Information Center (PIC) listed on page 116.



The majority of our data converters have an evaluation module (EVM) available, to allow the designer to quickly verify performance in their system design. Recently, TI has introduced a new, modular system for evaluation modules that allows the designer to quickly prototype their system.

Imagine being able to prototype your entire signal chain — input signal conditioning, A/D conversion, processor, D/A conversion, and output signal conditioning — with simple building blocks. Imagine not having to lay out a printed circuit board just to evaluate a system signal processing idea.

With TI's modular evaluation modules, you can put together a complete data acquisition system featuring signal conditioning, ADC, and a processor — all in just a few minutes. And you can add on from there — a DAC, or more output signal conditioning. All modular EVM boards are plug-and-play, so just snap them together for a complete prototype.

You can also build your own modules to fit this system, to accommodate circuits that may not be available directly from TI. Guidelines for designing your own boards can be found on the TI website.

Start with the Processor

A processor is the heart of your system. Do you need the power of a DSP, or the features of a microcontroller? You're free to choose and explore these options with

the modular EVM system. The signal chain building blocks have the ability to easily snap into place on an interface card to connect them to most of TI's DSPs.

Don't need a DSP? TI's MSP430 microcontroller products and MicroSystem controllers feature analog functionality built-in. In many systems, external data conversion components may be needed to complement the built-in functions. For those cases, our broad range of data conversion products can be used with these microcontrollers.

Using FPGAs instead of a processor? Several third parties have developed interface boards that allow the signal chain building blocks to connect to their FPGA development systems.

If you just want to evaluate the device on the EVM using standard lab equipment, or want to try wiring the board into your existing system, the modular EVMs will allow for that as well, no processor needed. You have access to all the essential interface pins on the device through the standardized connectors. So no matter how you process the data, we've got a way to help you develop your system.

Ready to Get Started?

If you've decided to use a DSP in your system, all of the modular EVMs are compatible with the following DSKs, using the 5-6K interface board:

C5416 DSP Starter Kit
C5510 DSP Starter Kit
C6416 DSP Starter Kit
C6711 DSP Starter Kit
C6713 DSP Starter Kit

A listing of EVMs compatible with these DSKs can be found at the TI eStore.

www.ti.com/estore

If the MSP430 microcontroller is what you're using, Softbaugh's HPA449 board is a complete MSP430 development system which features sites into which you can connect the modular EVMs.

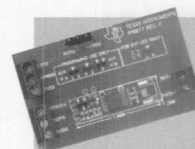
Developing with Modular EVMs

Developing software with the modular EVMs is easy. If you're using a DSP, our free Data Converter Plug-In for Code Composer Studio™ can help you set up the DSP to interface with the data converters.

If you're developing MSP430 code with Softbaugh's HPA449, you can use any of their tools to download programs to the MSP430's Flash. The HPA449 board also has the ability to program the Flash through the serial port.

Code Examples

Code for use with the modular EVMs on the different platforms can be found in the tool folder for the EVM. Look for the Related Software section in Related Documents in the tool folder. Very often, this code is a simple project that runs on the processor used; in some cases, complete software to evaluate data converters that runs on your PC is included as well.



EVALUATION MODULES (EVMs)

To order EVMs, please call our toll-free order desk number at 1-800-477-8924 ext. 5800 in North America.

To order in Asia, Europe, and other regions, contact the TI Product Information Center for your region or contact your local TI distributor (see www.ti.com/sc/docs/distmenu.htm for distributor listings.)

For a complete list of Analog EVMs visit: www.ti.com/sc/evms

Application Reports



To access any of the following application reports, type the URL www-s.ti.com/sc/techlit/litnumber and replace *lit number* with the number in the Lit Number column.

Title	Lit Number
Analog Monitor and Control Circuitry	
Measuring Temperature with the ADS1216, ADS1217, or ADS1218 (Rev. A)	sbaa073
NanoStar™ & NanoFree™ 300µm Solder Bump WCSP Application	sbva017
Analog Applications Journal (Rev. B)	slyt010b
Calibration Routines and Register Value Generation for the ADS121x Series	sbaa099
Solder Pad Recommendations for Surface-Mount Devices (Rev. A)	sbfa015a
Inputs Currents for High-Resolution ADCs	sbaa090
AB-174: Getting the Full Potential from your ADC (Rev. A)	sbaa069a
The Offset DAC	sbaa077
Measuring Temperature with the ADS1216, ADS1217, or ADS1218	sbaa073
AMC7820REF: A Reference Design for DWDM Pump Lasers	sbaa072
Amplifiers and Bits: An Introduction to Selecting Amplifiers for Data Converters (Rev. B)	sloa035b
Interfacing the ADS7870 and the MC68HC11E9 Analog to Microcomputer Made Easy	sbaa041
Using the ADS1202 Reference Design	sbaa186
Interfacing the ADS1202 Modulator w/a Pulse Transformer in Galvanically Isolated	sbaa096
Combining ADS1202 with FPGA Digital Filter for Current Measurement in Motor Control App	sbaa094
Choosing an Optocoupler for the ADS1202 Operating in Mode 1	sbaa088
Interfacing the ADS8361 to the TMS320F2812 DSP	sbaa167
Interfacing the ADS8364 to the TMS320F2812 DSP	sbaa163
Software Control of the ADS8364	sbaa155
Using a SAR ADC for Current Measurement in Motor Control Applications	sbaa081
Resetting Non-FIFO Variations of the 10-bit THS10064	sbaa144
Resetting Non-FIFO Variations of the 12-bit THS1206	sbaa145
Interfacing the ADS8361 to the TMS320C6711 DSP	sbaa164
Interfacing the ADS8361 to the TMS320VC5416 DSP	sbaa162
Designing with the THS1206 High-Speed Data Converter	sbaa094
Understanding Data Converters	sbaa013
Analog-to-Digital Converters	
ADC Offset in MSC12xx Devices (Rev. B)	sbaa097b
ADS5500, OPA695: PC Board Layout for Low Drivers Distortion High-Speed ADC	sbaa113
Overclocking the ADS1240 and ADS1241	sbaa084
ADCs Support Multicarrier Systems	sbaa001
Measuring Temperature with the ADS1216, ADS1217, or ADS1218 (Rev. A)	sbaa073a
NanoStar™ & NanoFree™ 300µm Solder Bump WCSP Application	sbva017
Interfacing the MSP430x11x(1) and TLV0831 (Rev. A)	sbaa092a
MSC12xx Programming with SDCC	sbaa109
RLC Filter Design for ADC Interface Applications	sbaa108
ADC Offset in MSCxx Devices (Rev. A)	sbaa097a
Analog Applications Journal (Rev. B)	slyt010b
ADC Gain Calibration - Extending the ADC Input Range	sbaa107
Controlling the ADS8342 with TMS320 Series DSP's	sbaa176
Clock Divider Circuit for the ADS1202 in Mode 3 Operation	sbaa105
Spreadsheet for Calculating the Frequency Response of the ADS1250-54 (Rev. A)	sbaa103
Operating the 16-bit, 5MSPS ADS1605 at Double the Output Data Rate	sbaa180
Interfacing the ADS8320/ADS8325 to TMS320C6711 DSP	sbaa17
Calibration Routines and Register Value Generation for the ADS121x Series	sbaa099
Interfacing the ADS8383 to TMS320C6711 DSP	sbaa174
Solder Pad Recommendations for Surface-Mount Devices (Rev. A)	sbfa015
Interfacing the TLV2541 to the MSP430F149	sbaa171
Inputs Currents for High-Resolution ADCs	sbaa090
Interfacing the TLC2552 and TLV2542 to the MSP430F149	sbaa168
Understanding the ADS1251, ADS1253, and ADS1254 Input Circuitry	sbaa086
Interfacing the ADS8345 to TMS320C5416 DSP	sbaa160
ADS1240, 1241 App-Note: Accessing the Onboard Temp Diode in the ADS1240 / ADS1241	sbaa083

Title	Lit Number
Pressure Transducer to ADC Application	sloa056
Understanding the ADS1252 Input Circuitry	sbaa082
Interfacing the ADS8364 ADC to the MSP430F149	sbaa150
Interfacing the TLC3544/48 ADC to the MSP430F149 (Rev. A)	sbaa126a
AB-174: Getting the Full Potential from your ADC (Rev. A)	sbaa069a
The Offset DAC	sbaa077
Measuring Temperature with the ADS1216, ADS1217, or ADS1218	sbaa073
Amplifiers and Bits: An Introduction to Selecting Amplifiers for Data Converters (Rev. B)	sloa035b
SPI-Based Data Acquisition/Monitor Using the TLC2551 Serial ADC (Rev. A)	sbaa108a
Implementing a Direct Thermocouple Interface with MSP430x4xx and ADS1240 (Rev. A)	sbaa125a
Interfacing the ADS7842 ADC to the TMS320C5400 and TMS320C6000 DSPs Platforms	sbaa130
Interfacing the ADS8320 ADC to the TMS320C5402 DSP	sbaa118
Interfacing the MSP430 and TLC549/1549 ADCs	sbaa112
Interfacing the ADS7822 to the TMS320C5402 DSP	sbaa107
Interfacing the TLV2541 ADC and the TLV5618A DAC to the TMS320C31 DSP	sbaa111
Interfacing the TLV2544/TLV2548 ADC to the TMS320C31 DSP	sbaa101
A Clarification of Use of High-Speed S/H to Improve Sampling ADC Performance	sbaa053
Complete Temp Data Acquisition System from a Single +5V Supply	sbaa050
Using the ADS7800 12-bit ADC with Unipolar Input Signals	sbaa044
ADS121x ADC Applications Primer	sbaa022
ADS7809 Tag Features	sbaa007
Accessing the ADS1210 Demo Board with Your PC	sbaa011
CDAC Architecture gives ADC574 Pinout/Sampling, Low Power, New Input Ranges	sbaa043
Coding Schemes used with Data Converters	sbaa042
Comparing the ADS1201 to the CS5321 (745k)	sbaa039
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